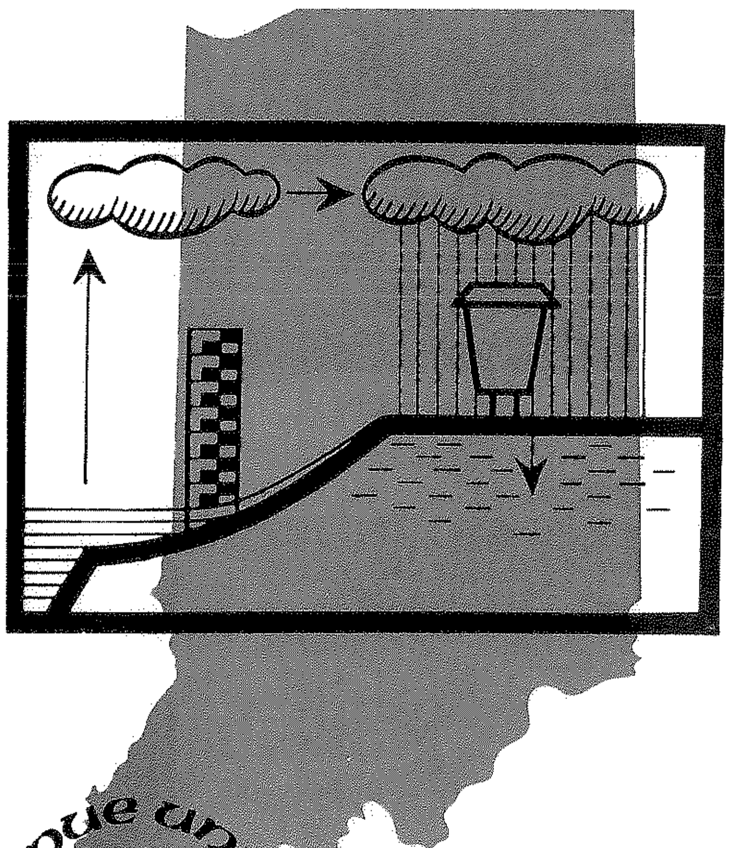
TECHNICAL REPORT 159

# OCCURRENCE PROBABILITIES OF ANTECEDENT MOISTURE CONDITION CLASSES IN INDIANA



by

Donald D. Gray

Christopher B. Burke

June 1983

PURDUE UNIVERSITY
WATER RESOURCES RESEARCH CENTER
WEST LAFAYETTE, INDIANA

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ABSTRACT

Discrete Antecedent Moisture Condition (AMC) classes are the simplest means to account for the influence of initial watershed moisture on runoff. AMC classes are used to adjust the abstraction parameters in two widely used hydrologic models: the Soil Conservation Service Curve Number method and the Illinois Urban Drainage Area Simulator computer program (ILLUDAS). In this report, a total of 258 years of daily weather observations at 10 Indiana stations has been used to estimate the seasonal and monthly occurrence probabilities of the Curve Number and ILLUDAS AMC classes. Similar results can now be obtained for any location in Indiana by interpolation. This information will provide guidance to hydrologists who must postulate an AMC class for use in design calculations.

The methodology of this study is explained and justified. A listing of the computer program used to analyze the data is included. Shortcomings of the present AMC criteria are discussed, and the results of certain possible modifications are presented. Cumulative Distribution Functions of 5-day antecedent rainfall are tabulated so that future researchers can investigate alternative criteria without having to reanalyze the original data.

# Chapter 1

# INTRODUCTION

## 1.1. Purpose

Predicting the volume of direct runoff from a rainstorm is one of the most important goals of hydrology. Early in the history of this science, it was recognized that for a given storm, direct runoff volume is usually much less than rainfall volume; and most runoff models embody this observation. Interception, depression storage, and soil moisture storage are just a few of the factors responsible for this reduction. Each is exceedingly complex and has been the subject of several monographs. One feature which these diverse mechanisms share is their variability with respect to time and space, both within a given watershed and from one watershed to another. It is therefore impractical to incorporate first-principles descriptions of the abstraction mechanisms into practical runoff models. Instead, some crude parameterizations must be invoked if ease of use is to be achieved.

One observation on which there is general agreement is that direct runoff from a storm normally increases with pre-storm watershed moisture content, other things being equal. A common, if not satisfying, scheme to account for the dependence of abstractions on initial watershed moisture is to define several discrete Antecedent Moisture Condition (AMC) classes based on the total precipitation during a specified period of time preceding the storm of interest. The model parameters which determine the abstractions are adjusted depending on the AMC class. It is easy to apply such schemes when calculating the runoff from historical storms if the appropriate antecedent rainfall data are available. To treat hypothetical or design storms, the analyst must postulate appropriate AMC classes, considering both the purpose of the calculations and the local climate. This report provides a rational basis for such choices in Indiana by reporting the actual percentage of time spent in the various AMC classes of two widely used runoff models: the Soil Conservation Service Curve Number method and the Illinois Urban Drainage Area Simulator (ILLUDAS). In addition, results are presented which allow future researchers to investigate the desirability of introducing new AMC class definitions.

## 1.2. SCS Curve Number Method

The Curve Number (CN) method is a simple empirical technique developed by the Soil Conservation Service (SCS) to calculate the direct runoff volume caused by a given depth of rain (Mockus, 1972; Rallison, 1980; Rallison and Miller, 1982). The CN method applies to both rural and urban watersheds (SCS, 1975) and has been used around the world (Hawkins, 1978). It has been recommended for the calculation of excess rainfall in several unit hydrograph techniques (Delleur, 1979; Kent, 1973; McCuen, 1982; Pope, 1973; SCS, 1975). Hawkins (1978) has provided a critical discussion of the theoretical basis of the CN method. Experimental tests of the CN method have been reported by Hawkins (1979); Hjelmfelt (1980); Hjelmfelt, Kramer, and Burwell (1982); Bales and Betson (1982); and Hope and Schulze (1982).

The heart of the CN method is the SCS Runoff Equation, a simple algebraic formula relating the direct runoff volume to the total rainfall volume and the Curve Number.

$$R = \frac{[P - 0.2S]^2}{P + 0.8S}, \qquad P > 0.2S \tag{1}$$

$$S = \frac{1000}{CN} - 10 \tag{2}$$

where R = direct runoff (inches)
P = rainfall (inches)
S = "ultimate abstraction" (inches)
CN = curve number (dimensionless)

The Curve Number is an empirical factor which reflects the abstraction characteristics of the watershed. An ideal impervious surface for which all rainfall becomes runoff would have CN = 100. An ideal previous surface which absorbs all rainfall would have CN = 0. The SCS established Curve Numbers for real surfaces by analyzing rainfall and runoff measurements from a large series of experimental watersheds having various known soil and cover types. For each watershed, the maximum one day runoff volume in each year was plotted against that day's total rainfall. In order to account for the scatter observed in these graphs, three Curve Numbers were associated with each watershed. The CN which resulted in an equal number of high and low runoff predictions was associated with AMC II. For these watersheds, AMC II may be considered as an "average" condition <u>for annual floods</u>. Lower and upper enveloping CNs were associated with AMC I and AMC III, respectively. These results were used by the SCS to produce tables of CN values for various combinations of soil class and natural or artificial cover type (Mockus, 1972; SCS, 1975). The tabulated CN values are for AMC II and may be adjusted downward for drier conditions (AMC I) or upward for wetter conditions (AMC III), in accordance with a conversion table provided by the SCS (Mockus, 1972). These adjustments have a dramatic effect on runoff predictions. Burke (1979) reported that this AMC adjustment results in an 18 fold variation in runoff volume from a typical Indiana subdivision (121 acres, SCS Type B soil, 30% impervious cover).

There can be little doubt that antecedent moisture was not the sole cause of the scatter in the data from which the CN tables were derived. Variations in storm pattern and vegetation were surely important. In some cases these other sources of variability may mask the effects of antecedent moisture. Nevertheless, the AMC classes are a reasonable means for accounting for at least some of this variability.

One of the primary goals of the SCS in devising the CN method was to provide a runoff model which could be applied to ungaged watersheds, or to those undergoing modification, using readily available daily rainfall data (Rallison, 1980; Rallison and Miller, 1982). Obviously, the AMC class in such cases must be based on antecedent rainfall totals. Page 10.5 and 10.6 of Mockus (1972) give explicit directions: "In the SCS method, the change in S (actually CN) is based on an antecedent moisture condition (AMC) determined by the total rainfall in a 5 day period preceding the storm... The rainfall amounts on which the selection is based are given in Table 4.2..." These criteria are repeated here in Table 1.

Table 1. Antecedent Moisture Condition Criteria.

| AMC CLASS | TOTAL 5-DAY ANTECEDENT RAINFALL (INCHES) | |
|---|---|---|
| | Growing Season (April 1 - October 31) | Dormant Season (November 1 - March 31) |
| SCS AMC I<br>SCS AMC II<br>SCS AMC III<br>SCS AMC IV* | less than 1.4<br>1.4 to 2.1<br>over 2.1<br>Frozen soil or snow cover** | less than 0.5<br>0.5 to 1.1<br>over 1.1<br>Frozen soil or snow cover** |
| ILLUDAS AMC 1<br>ILLUDAS AMC 2<br>ILLUDAS AMC 3<br>ILLUDAS AMC 4<br>ILLUDAS AMC 5* | 0<br>0 to 0.5<br>0.5 to 1.0<br>over 1.0<br>Frozen soil or snow cover** | NOT APPLICABLE |

* SCS AMC IV and ILLUDAS AMC 5 are not defined in the original literature. They have been added by the present authors for this study.

**The frozen/snow cover condition is assumed to occur whenever the average daily air temperature is less than or equal to 32°F or whenever there is measurable snow on the ground.

It should be noted that the basis for the particular numerical values in Table 1 has apparently never been published by the SCS. Different AMC class limits are used for the dormant and growing seasons. The dates of these seasons were established for Indiana by the present authors as explained in Chapter 2. Since the CN method is not applicable when the soil is frozen or snow covered, the present authors added AMC IV for the purposes of this study.

For calculations involving measured historical storms, the application of the criteria in Table 1 is unambiguous. When an AMC class must be selected for calculations of runoff from hypothetical storms, there are no generally accepted guidelines. As McCuen (1982) points out, this is actually a policy decision. It is the contention of the authors that one important consideration in this choice is the probability of occurrence of each AMC class. In the present study, 258 years of daily weather observations at 10 Indiana stations have been analyzed to provide estimates of those probabilities.

## 1.3. The Illinois Urban Drainage Area Simulator

ILLUDAS is a nonpropriety computer program developed by the Illinois State Water Survey (Terstriep and Stall, 1974) for the design or evaluation of storm sewer systems. Given the layout of an existing or proposed storm sewer network and an arbitrary rainfall hyetograph, the program calculates direct runoff hydrographs at each junction and specifies the requisite commercial pipe diameters. ILLUDAS is widely used and its performance has been studied by several investigators (Burke and Gray, 1980; Burke and Gray, 1981; Burke, Rao, and Gray, 1980; Wenzel and Terstriep, 1976).

ILLUDAS determines the direct runoff from grassed areas by comparing the rainfall rate at each time step with the infiltration capacity predicted for bluegrass lawns by Horton's empirical equation (Linsley, Kohler, and Paulhus, 1982). Different initial and ultimate infiltration capacities are specified for each of the four SCS soil types. Antecedent moisture effects are modeled by defining four AMC classes with corresponding initial infiltration capacities for each soil type. Wetter soils are assigned a higher AMC class and have a reduced initial infiltration capacity. For the typical Indiana subdivision mentioned previously, Burke (1979) found that the required outfall pipe diameter increased from 72 inches to 90 inches as the AMC class was varied.

The ILLUDAS AMC classes are determined by the total rainfall on the 5 days preceding the storm using the criteria given in Table 1. The present authors have defined AMC 5 for the purposes of this study because ILLUDAS does not apply when the ground is frozen or snow covered. In the documentation for ILLUDAS, no distinction is made between the dormant and growing seasons; however, the present authors believe that the infiltration capacities used in ILLUDAS are not valid during the dormant season in Indiana. For this reason the ILLUDAS criteria were applied only during the growing season.

Although both the SCS and ILLUDAS AMC classes are based on 5 day antecedent rainfall totals, the class limits used in the two models are quite different.

In recent years, the original ILLUDAS program has been modified to allow extended period simulations. A version developed by Han and Delleur (1979) automatically calculates a 5-day antecedent rainfall total and selects an AMC based on the criteria of Table 1. Noel and Terstriep (1982) have developed Q-ILLUDAS which includes a more sophisticated soil moisture model which, at least in principle, is much more satisfactory than using discrete AMC classes. Unfortunately, Q-ILLUDAS also requires significantly more detailed input data and is not expected to be as widely used as ILLUDAS. Both extended period versions require input of long period hyetographs and thus eliminate the need to directly postulate an AMC.

## 1.4. Previous AMC Studies

The only previous research on AMC occurrence probabilities has been carried out by the senior author and his co-workers. Gray and Cogo (1981) presented a detailed analysis of CN and ILLUDAS AMC probabilities based on the 1960-1977 data for West Lafayette, Indiana. The present study extends these results using data from 1954-1977. Gray, Katz, Mishler, and Cogo (1982) computed growing season AMC probabilities for 17 stations in Indiana, Kentucky, and Tennessee. Among the 5 Indiana stations, only West Lafayette had data of sufficient quality to merit inclusion in the present study. The Discussion and Closure of the 1982 paper is of special interest to users of the Curve Number method.

Highlights of this report have been summarized in a paper by Burke and Gray (1983). In general it can be said that the results of all these studies are in excellent agreement.

## 1.5. Outline of the Report

Chapter 2 explains the methodology used to obtain AMC probability estimates from daily meteorological data. Section 2.1 describes the criteria used to select 10 stations representative of the state of Indiana. The treatment of frozen ground, snow cover, and missing data is set forth in Section 2.2. Section 2.3 tells how the dates of the dormant and growing seasons were established. The question of determining the length of the time series needed to achieve stable results is answered in Section 2.4. Appendix 1 is a listing of the Fortran program used to analyze the data.

The main results of this study are contained in Chapter 3. Section 3.1 summarizes the SCS and ILLUDAS AMC probabilities for each station both by season and by month. Appendix 2 provides additional detail. Regression equations for the prediction of AMC probabilities knowing average annual precipitation are given in Section 3.2. Certain objections which have been raised to the approach used in this study are examined in Section 3.3 and found to be without practical importance in Indiana. Section 3.4 and Appendix 3 present monthly and annual cumulative distribution functions of 5-day antecedent precipitation by 0.1 inch increments for each station. These results form the basis for the consideration of redefining the present AMC criteria.

Chapter 4 is concerned with the prospects for improving the AMC criteria in use at the present time. Section 4.1 discusses the paradoxes inherent in the use of discrete AMC classes based on rainfall in fixed antecedent periods. A method for placing an upper bound on the probability of an AMC class given the available rainfall, antecedent period length, and class limit is explained in Section 4.2. Section 4.3 uses the cumulative distribution function results to establish 90th percentile 5-day antecedent rainfall totals for each station by month and by season. The effects produced by changing the length of the antecedent period are considered in Section 4.4.

Chapter 5 summarizes the results obtained in this project.

# Chapter 2

# METHODOLOGY

## 2.1. Selection of Stations

In order to produce results which would be useful throughout the state of Indiana, it was necessary to focus on a group of geographically dispersed stations for which relatively long records of reliable precipitation and temperature measurements were available. After discussions with State Climatologist Dr. Lawrence A. Schaal (now retired), the 10 stations shown in Figure 1 were selected. The nearest neighbor distances of these stations range from 40 miles to 85 miles, with a mean of 56 miles. Every point in Indiana is within 60 miles of one of these stations.

Additional information about these stations is provided in Table 2. The column headed "Years Studied" indicates the period used to derive the main results of this report. Because there were occasional missing data, not every day could be analyzed. The number and percentage of days which were included in the 5-day AMC analysis is listed. The last column gives the average annual precipitation for each station. The significance of these entries will be discussed in later sections.

Two magnetic tapes which contain all of the daily weather observations for every station in Indiana through 1977 were purchased from the National Oceanic and Atmospheric Administration. The daily record for each station used in this study includes the water equivalent precipitation, maximum and minimum air temperatures, and the depth of snow on the ground at the time of observation. These were the data used to determine the AMC for each day.

## 2.2. Frozen Ground, Snow Cover, and Missing Data

Since neither the Curve Number method nor ILLUDAS is valid when the ground is frozen or snow covered, these conditions merit special consideration. The most straightforward way to determine if the ground was frozen would be from actual soil temperature measurements, but these are available at only 12 sites in Indiana and begin in 1960 (Schaal, 1981). Among the 10 stations selected for this study, only West Lafayette reports such measurements.

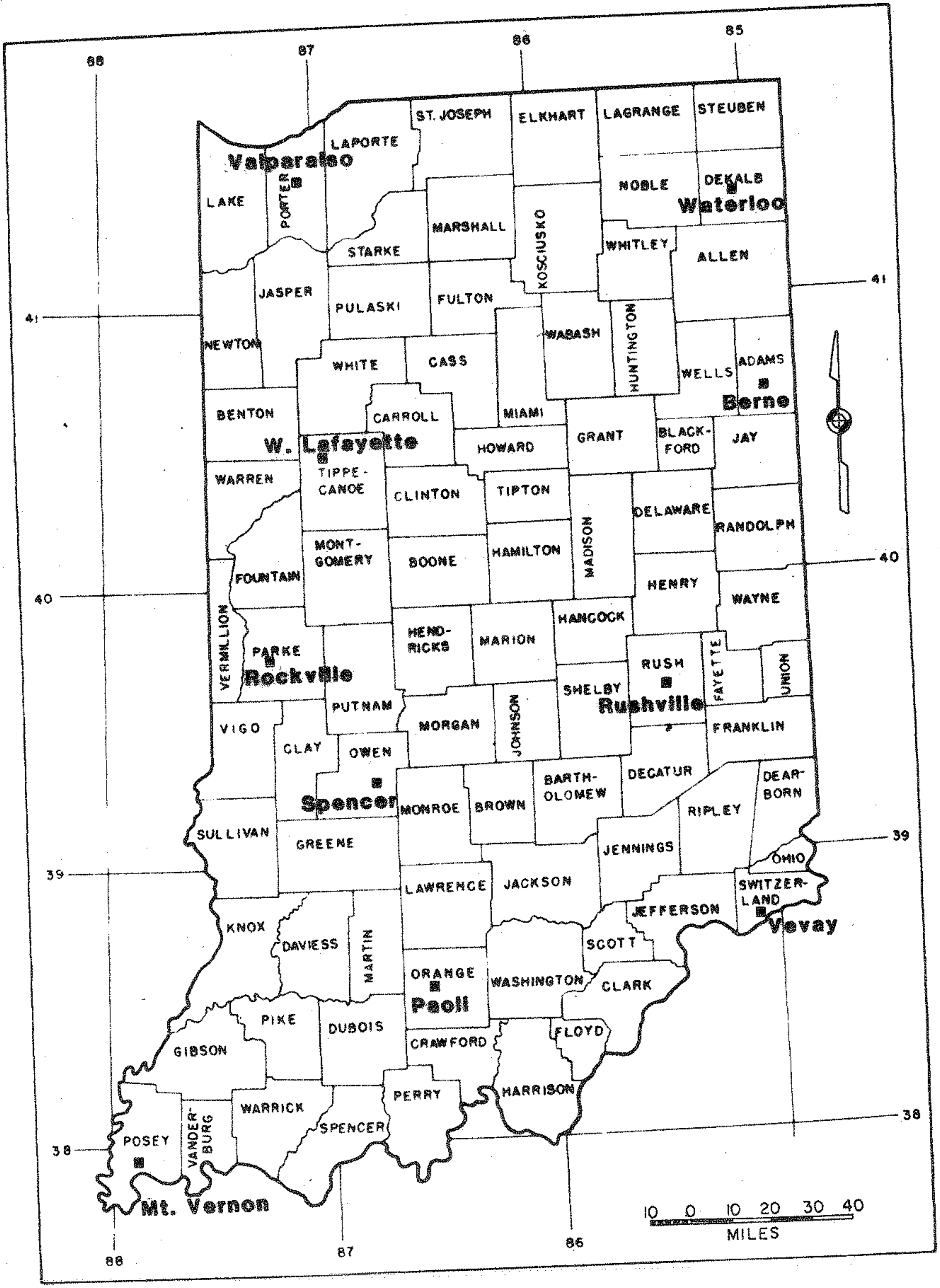



Figure 1. Map of Stations Analyzed.

Table 2. Stations Used in the 5-Day AMC Study.

| Station | I.D. Number | County | Years Studied | Number of Days Analyzed | Percent of Days Analyzed | Average Annual Precipitation[1] (inches) |
|---|---|---|---|---|---|---|
| 1. Berne | 0676 | Adams | 1948-77 | 10,587 | 97 | 36.94 |
| 2. Mt. Vernon | 6001 | Posey | 1948-77 | 10,334 | 94 | 43.17 |
| 3. Paoli | 6705 | Orange | 1948-77 | 9,572 | 87 | 45.42 |
| 4. Rockville | 7522 | Park | 1948-77 | 9,712 | 88 | 41.11 |
| 5. Rushville | 7646 | Rush | 1948-77 | 9,518 | 87 | 39.80[2] |
| 6. Spencer | 8290 | Owen | 1950-77 | 9,389 | 92 | 40.91[3] |
| 7. Valparaiso | 8999 | Porter | 1948-77 | 10,376 | 95 | 38.63 |
| 8. Vevay | 9080 | Switzer-land | 1961-77 | 5,914 | 95 | 41.63 |
| 9. Waterloo | 9271 | Dekalb | 1948-77 | 10,022 | 91 | 34.66 |
| 10. W.Lafayette[4] | 9430 | Tippe-canoe | 1954-77 | 8,692 | 99 | 36.88[5] |

1. Source: Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1941-1970, U.S. Department of Commerce, National Climatic Center, Asheville, N.C., August 1973.

2. Arithmetic average of nearest 4 stations: Shelbyville, Cambridge City, Greenfield, and Brookville.

3. Arithmetic average of nearest 4 stations: Bloomington, Martinsville, Elliston, and Terre Haute.

4. Purdue Agronomy Farm

5. Purdue Airport

In addition, soil temperature varies dramatically with location because it depends strongly on exposure, depth of measurement, and soil type. For these reasons it was not practical to use soil temperature measurements to establish the occurrence of SCS AMC IV and ILLUDAS AMC 5.

McGarrahan and Dale (1980) have investigated the accuracy of regression equations for the prediction of soil temperature from air temperatures, but their results did not warrant the incorporation of such a procedure in this work. Therefore, for the purpose of this study, "frozen ground" was deemed to occur if the average of the maximum and minimum air temperatures was less than or equal to 32.0°F. If this occurred or if there was more than a "trace" of snow on the ground at the time of the observation, the day was counted in SCS AMC IV and ILLUDAS AMC 5. The water equivalent of all precipitation falling during a series of "frozen ground" days (regardless of length) was accumulated and counted as rain on the last day of the series. This simplistic treatment neglects the possibility of gradual evaporation or melting, but it is no more arbitrary than any other scheme to account for snowfall using the available information.

A Fortran program was written by the junior author which read the appropriate data, formed 5-day antecedent water equivalent precipitation totals, and assigned each day to the appropriate AMC class. (A complete listing is given in Appendix 1.) Whenever any of the 4 observations was missing, that day and the next 5 days were not assigned to an AMC class. Table 3 illustrates the application of these rules. The ratio of the number of days in each class to the total was used to estimate the probability of the occurrence of that class. In his Discussion of Gray, Katz, deMonsabert, and Cogo (1982), McCuen objected to this approach because it is based on assigning all days to AMC classes, even those days on which no rain occurs. In essence, he points out that the present methodology estimates unconditioned AMC probabilities, whereas the quantities of interest are the AMC probabilities given that a storm of a certain magnitude will occur. In Section 3.3 it will be argued that this distinction has no practical importance in Indiana.

## 2.3. Definition of Growing and Dormant Seasons.

The definition of the dormant and growing seasons required judgement. Climatologists often define the growing season as the period from the last air temperature of 32°F in the spring until the first air temperature of 32°F in the fall. To implement such a definition would require checking all the minimum temperatures until the first fall freeze before the growing season could be defined. Since each year's growing season would be different, it would be impossible to state whether growing or dormant criteria should be used during future springs and falls. These problems could be overcome by using average growing seasons, but these differ among stations. Schaal and Newman (undated) have established average growing seasons for 7 of the stations used in this study and for stations close to the others. The average date of the last occurrence of 32°F in the spring ranges from April 9 to May 5 with a mean date of April 25. The average date of the first fall occurrence of 32°F ranges from October 9 to October 25 with a mean date of October 17. To avoid the inconvenience of splitting months between the seasons, the growing season was defined to last from April 1 through October 31 for every station in this study. It is interesting to observe that although this definition differs from those in our previous studies, the results are in good agreement.

Table 3. Application of AMC Criteria to Hypothetical Data.

| Date | Average Air Temperature [°F] | Snow Depth [inches] | Precipitation [inches] | 5-Day Antecedent Moisture | SCS AMC | Comments |
|---|---|---|---|---|---|---|
| Jan. 1 | 33 | 0 | 0.2 | 0 | I | Dormant Season, ILLUDAS not used. |
| 2 | 33 | 0 | 0 | 0.2 | I | |
| 3 | 35 | 0 | 0.5 | 0.2 | I | |
| 4 | 35 | 0 | 0 | 0.7 | II | |
| 5 | 37 | 0 | 0.1 | 0.7 | II | |
| 6 | 35 | 0 | 0 | 0.8 | II | |
| 7 | 33 | 0 | 0 | 0.6 | II | |
| 8 | 28 | 0 | 0 | * | IV | "Frozen ground". |
| 9 | 33 | 0 | 0 | 0.1 | I | |
| 10 | 36 | 0 | 0 | 0 | I | |
| 11 | 35 | 1.0 | 0.1 | * | IV | "Snow cover". |
| 12 | 28 | 0 | 0 | * | IV | "Frozen ground". |
| 13 | 35 | 0 | 0 | 0.1 | I | |
| 14 | 35 | 0 | 0.5 | 0.1 | I | |
| 15 | 37 | 0 | 0 | 0.6 | II | |
| 16 | 38 | 0 | 0 | 0.6 | II | |
| 17 | 39 | 0 | 0 | 0.6 | II | Snow of Jan. 11 assumed to melt on Jan. 12. |
| 18 | Missing | 0 | 0 | * | Bad | Missing data invalidates 6 days. |
| 19 | 40 | 0 | 0 | * | Bad | |
| 20 | 28 | 1.0 | 0.1 | * | Bad | |
| 21 | 27 | 0 | 0 | * | Bad | |
| 22 | 33 | 0 | 0.4 | * | Bad | |
| 23 | 28 | 0 | 0 | * | Bad | |
| 24 | 28 | 0 | 0 | * | IV | "Frozen ground". |
| 25 | 35 | 0 | 0 | 0.5 | II | |
| 26 | 34 | 0 | 0 | 0.5 | II | Snow of Jan. 20 assumed to melt on Jan. 21. |
| 27 | 35 | 0 | 0 | 0.4 | I | |

*Not used.

## 2.4. Selection of the Period of Analysis.

In any climatological study, the selection of the length of the data series to be analyzed requires a compromise among three objectives. A long period helps to insure statistical reliability, but the period should be short enough to minimize the effects of climatic change and the expense of the computations. In order to select an appropriate period for this study, the entire record for Berne from 1910 through 1977 was analyzed. Berne was used because it had one of the longer records and because its position near the start of our data tape reduced the expense of the computations significantly.

Figure 2 shows the results for the SCS dormant season probabilities. There are significant variations from year to year, but the averages for two 30 year periods (1918 through 1947 and 1948 through 1977) differ from the 68 year average (1910 through 1977) by 1% or less. Figure 3 shows that the same conclusions can be drawn for the SCS growing season criteria. The 30 year ILLUDAS results in Figure 4 do not vary from the 68 year average by more than 2%. These results are summarized in Table 4. It may be concluded that a 30 year period, which is customary for many climatological averages, is also satisfactory for this study.

Table 4. Effects of Various Averaging Periods on Berne, Indiana, Results.

| | 5-Day AMC Probabilities | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCS Dormant | | | | SCS Growing | | | | ILLUDAS | | | | |
| Period | I | II | III | IV | I | II | III | IV | 1 | 2 | 3 | 4 | 5 |
| 1918-47 | 29 | 12 | 11 | 48 | 87 | 7 | 5 | 1 | 19 | 42 | 17 | 21 | 1 |
| 1948-77 | 27 | 10 | 13 | 50 | 88 | 8 | 4 | 0 | 20 | 39 | 20 | 21 | 0 |
| 1910-77 | 28 | 11 | 12 | 49 | 88 | 7 | 4 | 1 | 19 | 41 | 18 | 21 | 1 |

As Table 2 shows, the results for 7 stations are based on the 30 year period from January 1, 1948, through December 31, 1977. The remaining 3 stations began reporting at later dates and so were studied for shorter periods. Spencer's period is 28 years (1950 through 1977), Vevay's period is 17 years (1961-1977), and West Lafayette's period is 24 years (1954-1977). Table 2 also lists the percentage of days which were actually assigned to a 5-day AMC class. The percentage of days which could not be classified due to incomplete data ranged from 1% at West Lafayette up to 13% at Paoli and Rushville. The average was 7%. The great majority of excluded days occurred during the dormant season. A total of 94116 days were classified in the 5-day AMC study.

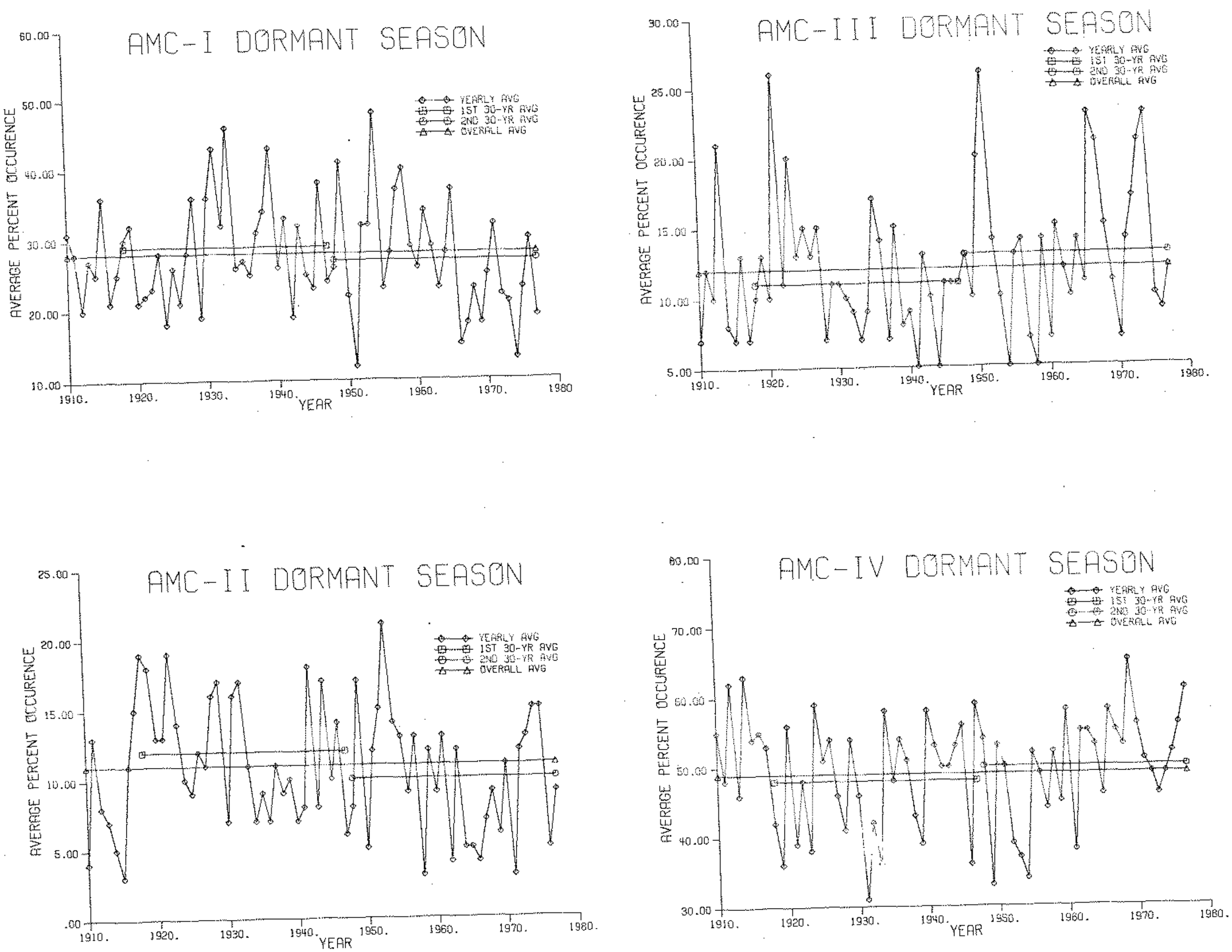



Figure 2. SCS Dormant Season AMC Probabilities: Berne, 1910-1977.

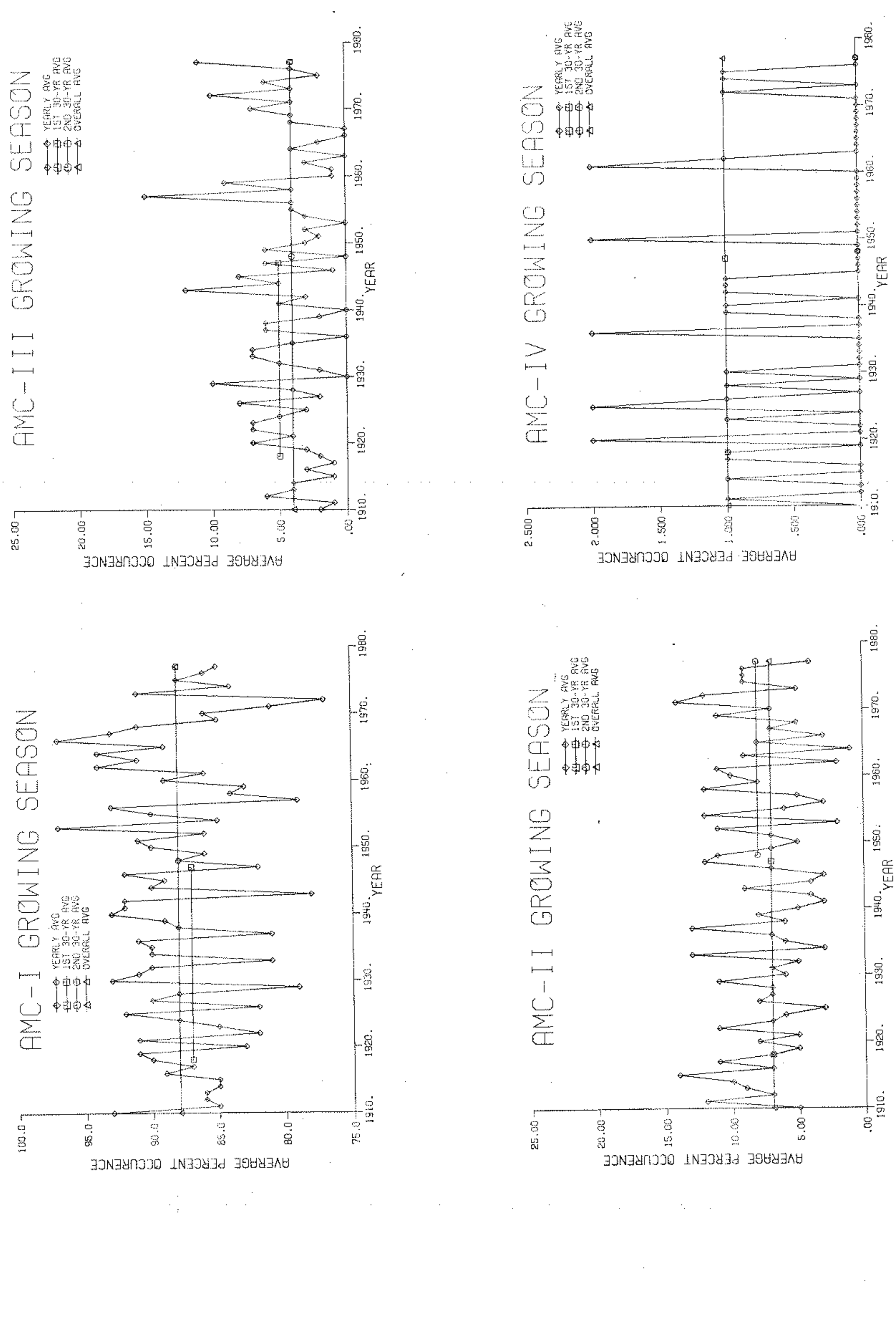



Figure 3. SCS Growing Season AMC Probabilities: Berne, 1910-1977.

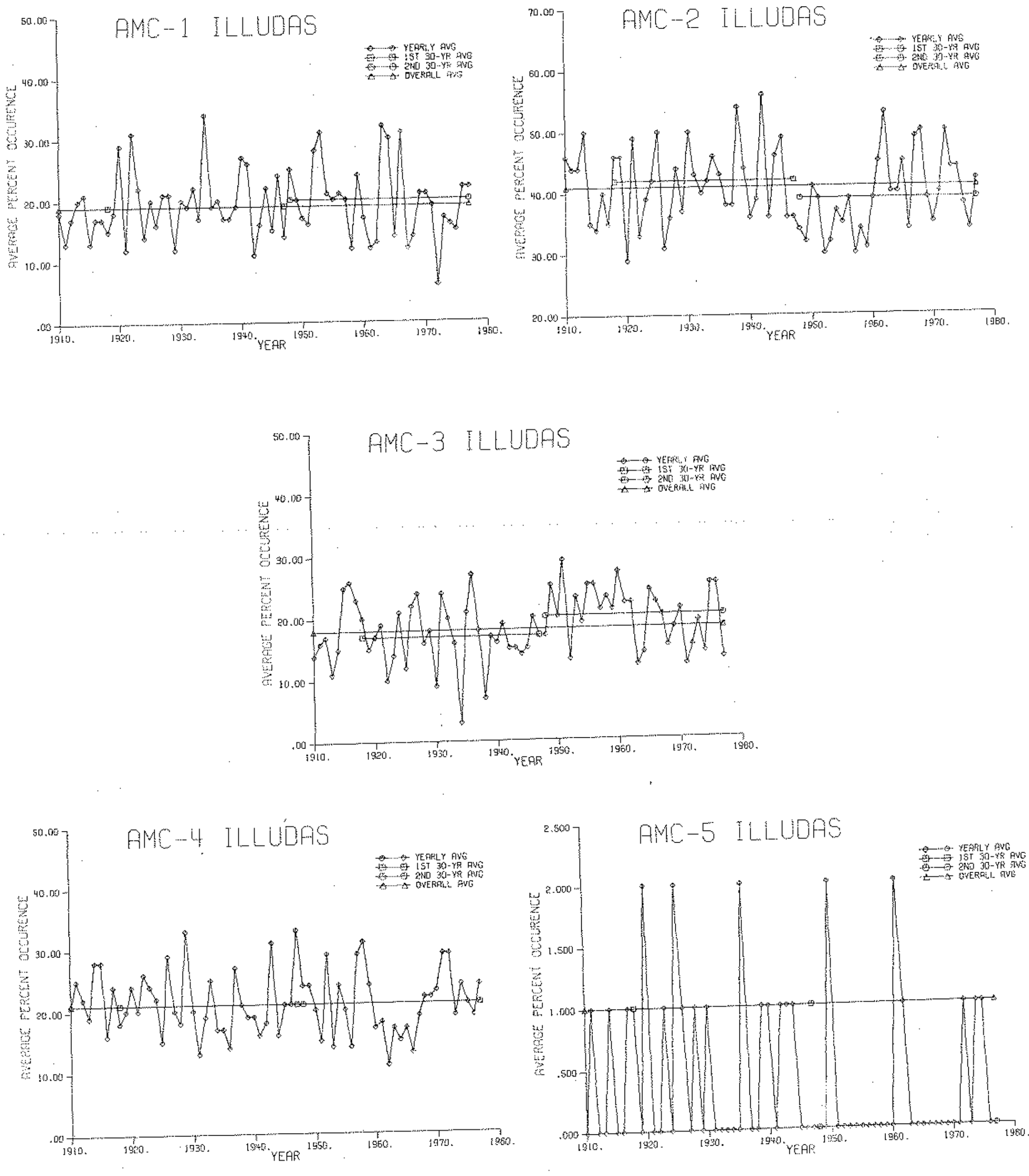



Figure 4. ILLUDAS AMC Probabilities: Berne, 1910-1977.

# Chapter 3

# RESULTS

## 3.1. SCS and ILLUDAS AMC Probabilities

The primary results of this study are the seasonal AMC probabilities according to the SCS and ILLUDAS criteria for 5-day antecedent precipitation. These results are presented in Table 5 and Figures 5 through 7. The Indiana average results are not arithmetic averages of the individual station results but are based on the total number of days analyzed.

The SCS growing season probabilities are remarkable for their uniformity among stations and for the overwhelming predominance of AMC I. The latter is due to the high class limit of 1.4 inches of rain. The probability that any growing season day will be in AMC I is greater than 85% at every station. It is clearly incorrect to think of AMC II as an average condition. For the state as a whole, SCS AMC IV has a probability of less than 0.4% during the growing season, as does ILLUDAS AMC 5. This low probability vindicates the April 1 through October 31 growing season.

The SCS dormant season results show far more variation among stations, especially in AMC IV, the frozen soil or snow cover class. This probability ranges from 32% at Vevay to 57% at Waterloo and Valparaiso. Table 6 demonstrates that this trend correlates very closely with annual average temperature and with latitude, the colder stations having a greater AMC IV probability. The most important conclusion, however, is that the CN method is invalid for almost half of the dormant season for the state as a whole.

The ILLUDAS results, which refer to the growing season, show a fair degree of uniformity both among stations and among classes. This latter feature makes the selection of a design AMC rather critical.

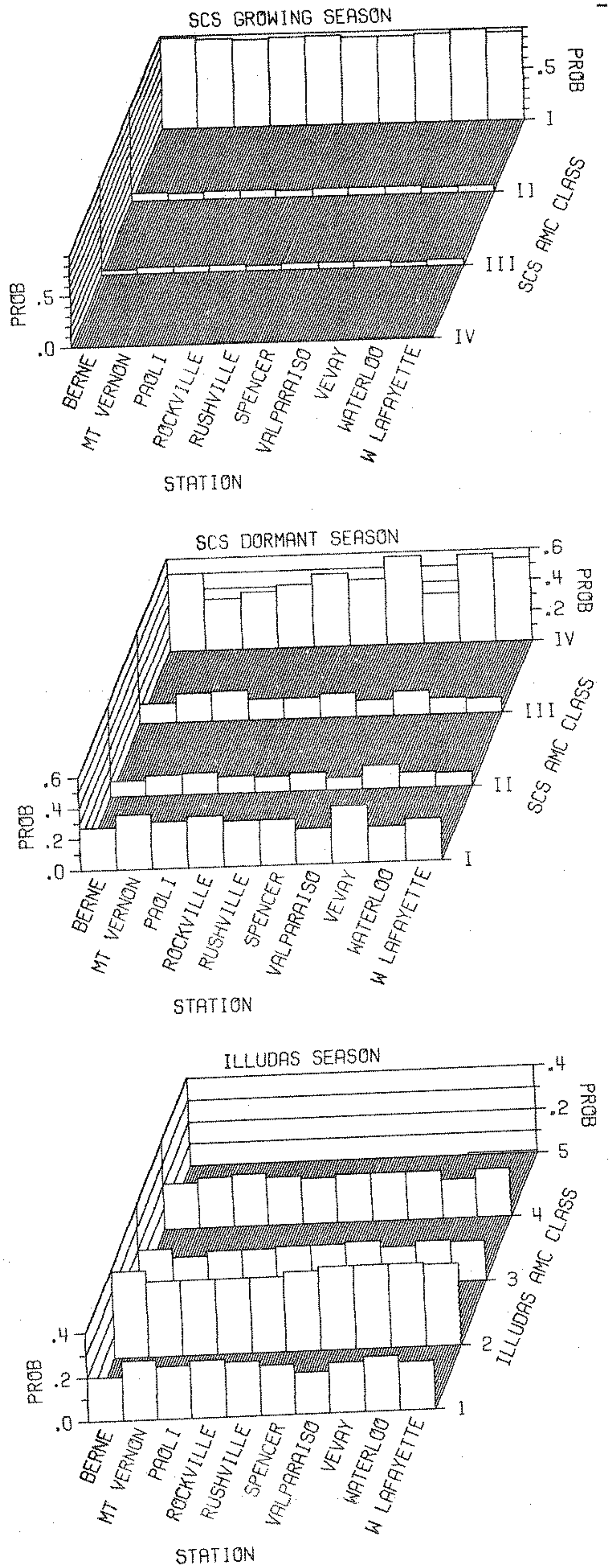



Figure 5. Seasonal AMC Probability Histograms for Each Station and for Indiana.

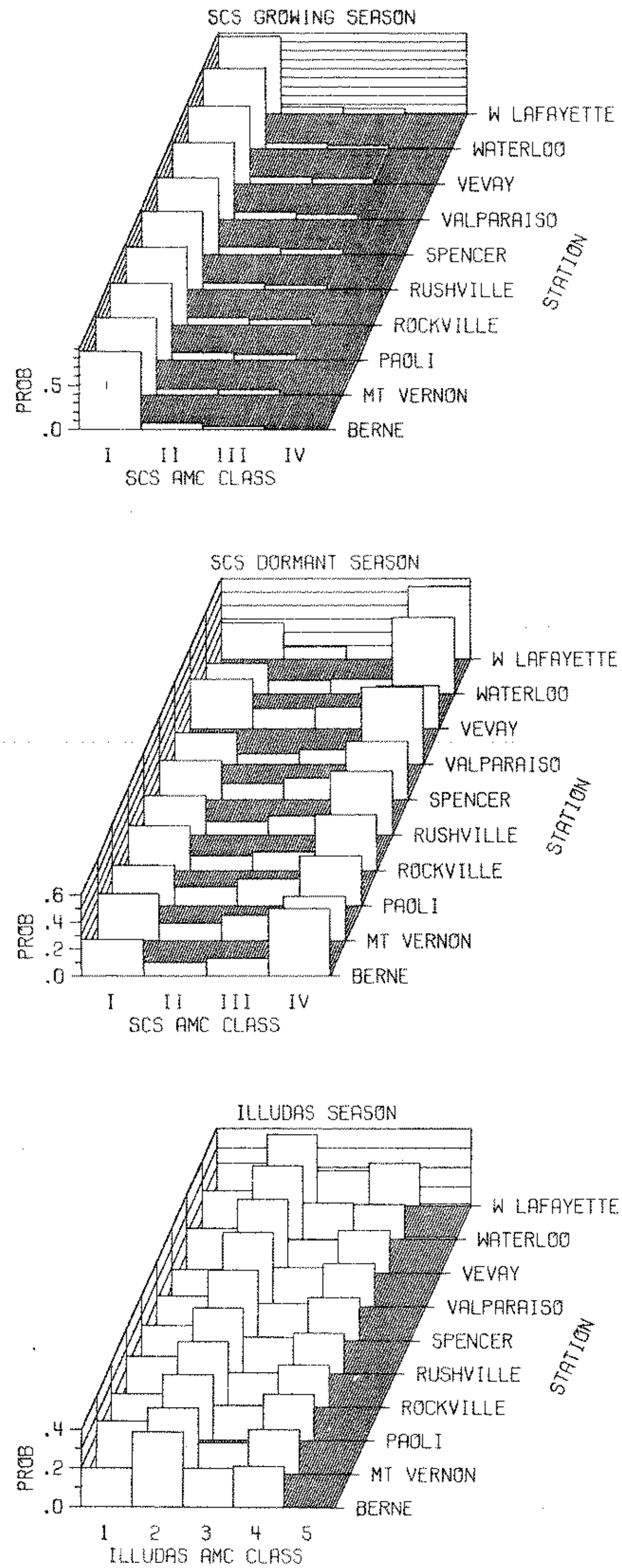
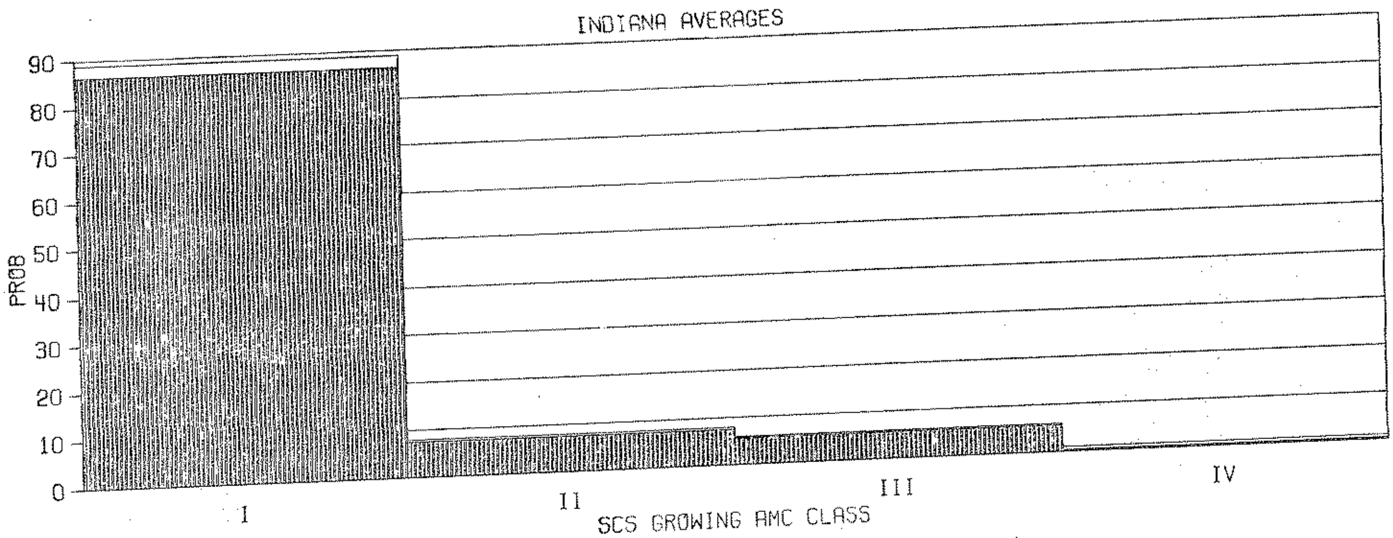
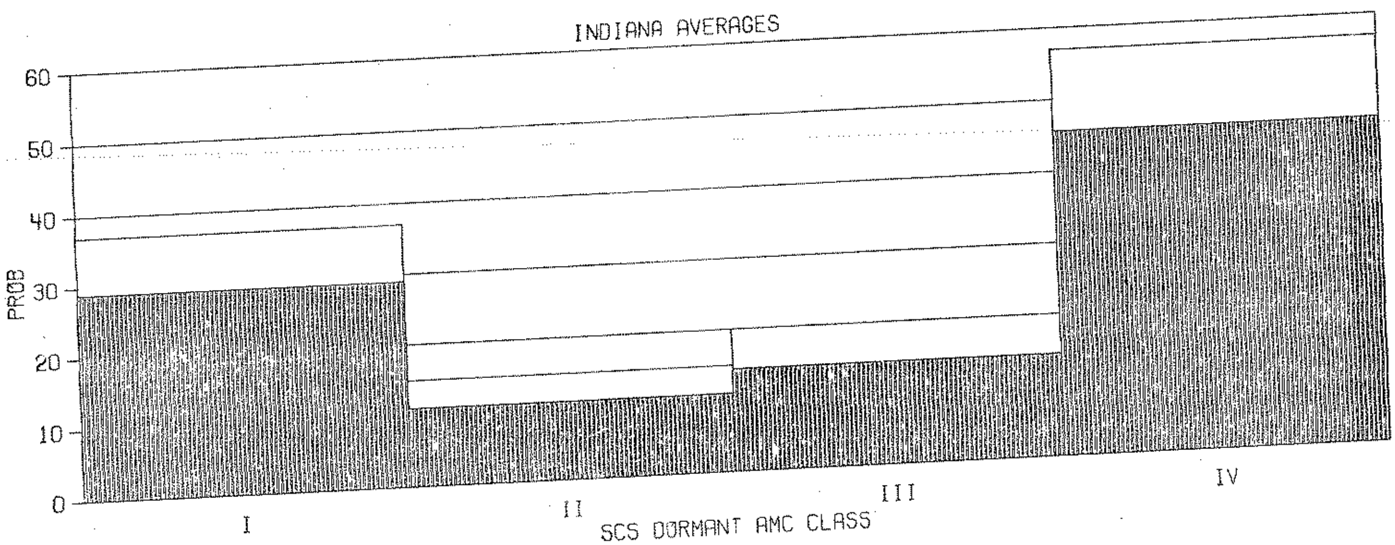



Figure 6. Seasonal AMC Probability Histograms for Each Station.



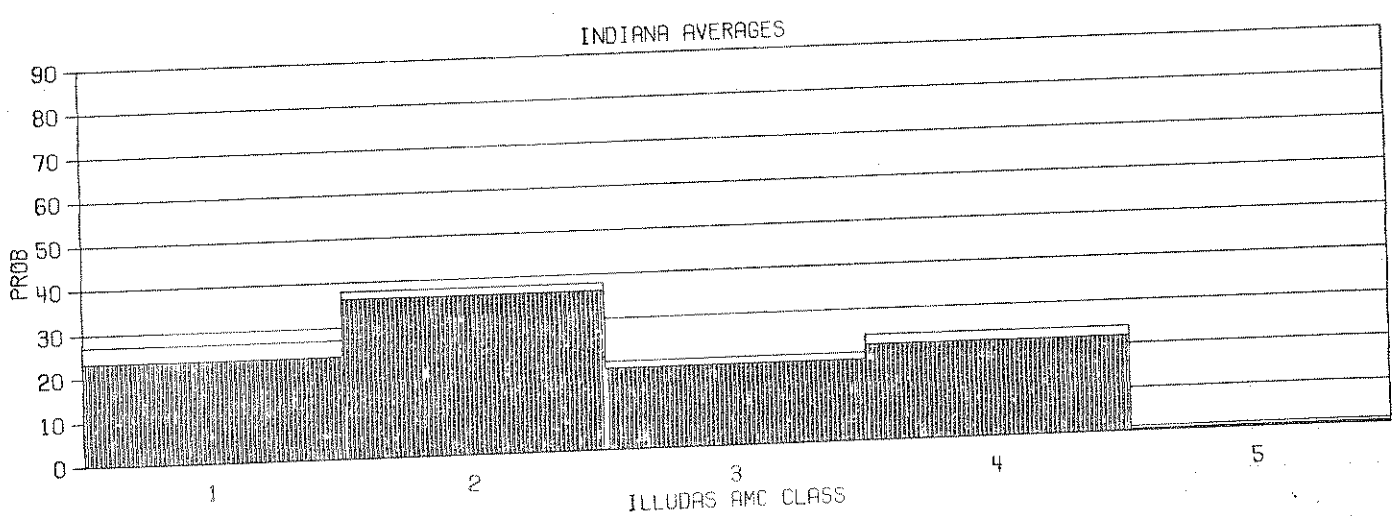




Figure 7. Indiana Average Seasonal AMC Probability Histograms (Shaded Areas). Maximum Probability Indicated By Unshaded Areas.

Table 7. Indiana Average Monthly AMC Probabilities.

| Month | SCS AMC [%] | | | | ILLUDAS AMC [%] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | 1 | 2 | 3 | 4 | 5 |
| Jan.* | 15 | 6 | 11 | 67 | - | - | - | - | - |
| Feb.* | 20 | 9 | 15 | 57 | - | - | - | - | - |
| March* | 35 | 17 | 21 | 28 | - | - | - | - | - |
| April | 84 | 9 | 5 | 2 | 13 | 39 | 21 | 25 | 2 |
| May | 87 | 8 | 6 | 0 | 21 | 36 | 21 | 23 | 0 |
| June | 84 | 9 | 8 | 0 | 21 | 32 | 20 | 27 | 0 |
| July | 85 | 9 | 7 | 0 | 21 | 36 | 19 | 24 | 0 |
| Aug. | 87 | 7 | 6 | 0 | 28 | 35 | 16 | 21 | 0 |
| Sept. | 89 | 6 | 5 | 0 | 27 | 38 | 16 | 18 | 0 |
| Oct. | 90 | 6 | 4 | 0 | 31 | 38 | 16 | 15 | 0 |
| Nov.* | 52 | 16 | 14 | 19 | - | - | - | - | - |
| Dec.* | 23 | 8 | 12 | 56 | - | - | - | - | - |

*Dormant season

Percentages may not sum to 100% due to rounding.

## 3.2. Results for Other Locations In Indiana.

In order to generalize the results of the previous section to other locations in Indiana, AMC probabilities were regressed against average annual precipitation (Table 2). The computations were performed using the Statistical Package for the Social Sciences (SPSS). The resulting equations follow.

SCS Dormant Season

$$P_I = 1.01\ R - 11.12 \quad , \qquad r = 0.70 \tag{3}$$

$$P_{II} = 0.53\ R - 9.76 \quad , \qquad r = 0.75 \tag{4}$$

$$P_{III} = 0.96\ R - 23.75 \quad , \qquad r = 0.91 \tag{5}$$

$$P_{IV} = 100\% - P_I - P_{II} - P_{III} = -2.50\ R + 144.63 \tag{6}$$

where $P_x$ = percentage probability of AMC class X.

$R$ = average annual precipitation (inches)

$r$ = correlation coefficient

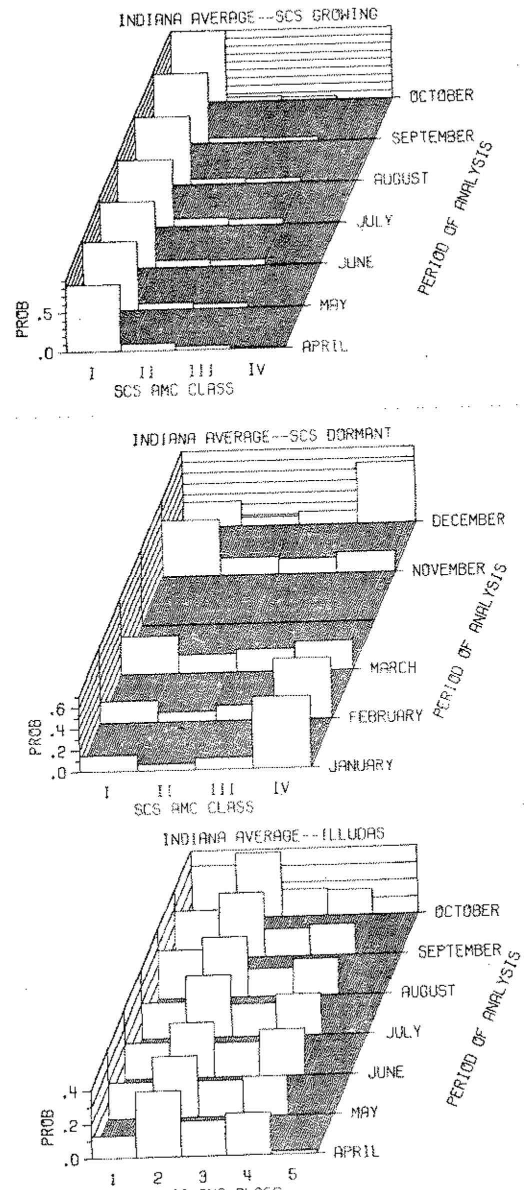



Figure 8. Indiana Average Monthly AMC Probability Histograms.

These equations are compared with the data in Figure 9. As suggested by the rather high correlation coefficients, the fit is good. It is interesting to note that only AMC IV shows negative correlation with R.

SCS Growing Season

$$P_I = -0.29\ R + 97.83 \quad , \qquad r = -0.70 \tag{7}$$

$$P_{II} = 0.11\ R + 3.06 \quad , \qquad r = 0.51 \tag{8}$$

$$P_{III} = 0.18\ R - 1.57 \quad , \qquad r = 0.67 \tag{9}$$

$$P_{IV} = 100\% - P_I - P_{II} - P_{III} \quad = 0.68 \tag{10}$$

The lower correlation coefficients indicate that these equations are less satisfactory than those for the dormant season. The reason, as made evident in Figure 10, is that only $P_I$ shows a clear trend with R.

ILLUDAS

$$P_1 = 0.30\ R + 11.26 \quad , \qquad r = 0.39 \tag{11}$$

$$P_2 = -0.44\ R + 53.81 \quad , \qquad r = -0.70 \tag{12}$$

$$P_3 = -0.23\ R - 27.41 \quad , \qquad r = -0.58 \tag{13}$$

$$P_4 = 0.41\ R + 5.34 \quad , \qquad r = 0.84 \tag{14}$$

$$P_5 = 100\% - P_1 - P_2 - P_3 - P_4 = -0.04\ R + 2.18 \tag{15}$$

Figure 11 shows that except for $P_1$, the "bone dry" probability, these equations provide a fairly good fit to the data.

Equations (7) through (15) may be used throughout Indiana and in neighboring states where R ranges from about 34 inches to about 46 inches. The choice of R as the independent variable was based on its ready availability throughout the region; no direct causal relationship is implied. Care should be used in extrapolation, particularly where the seasonal distribution of rainfall may differ from that of Indiana.

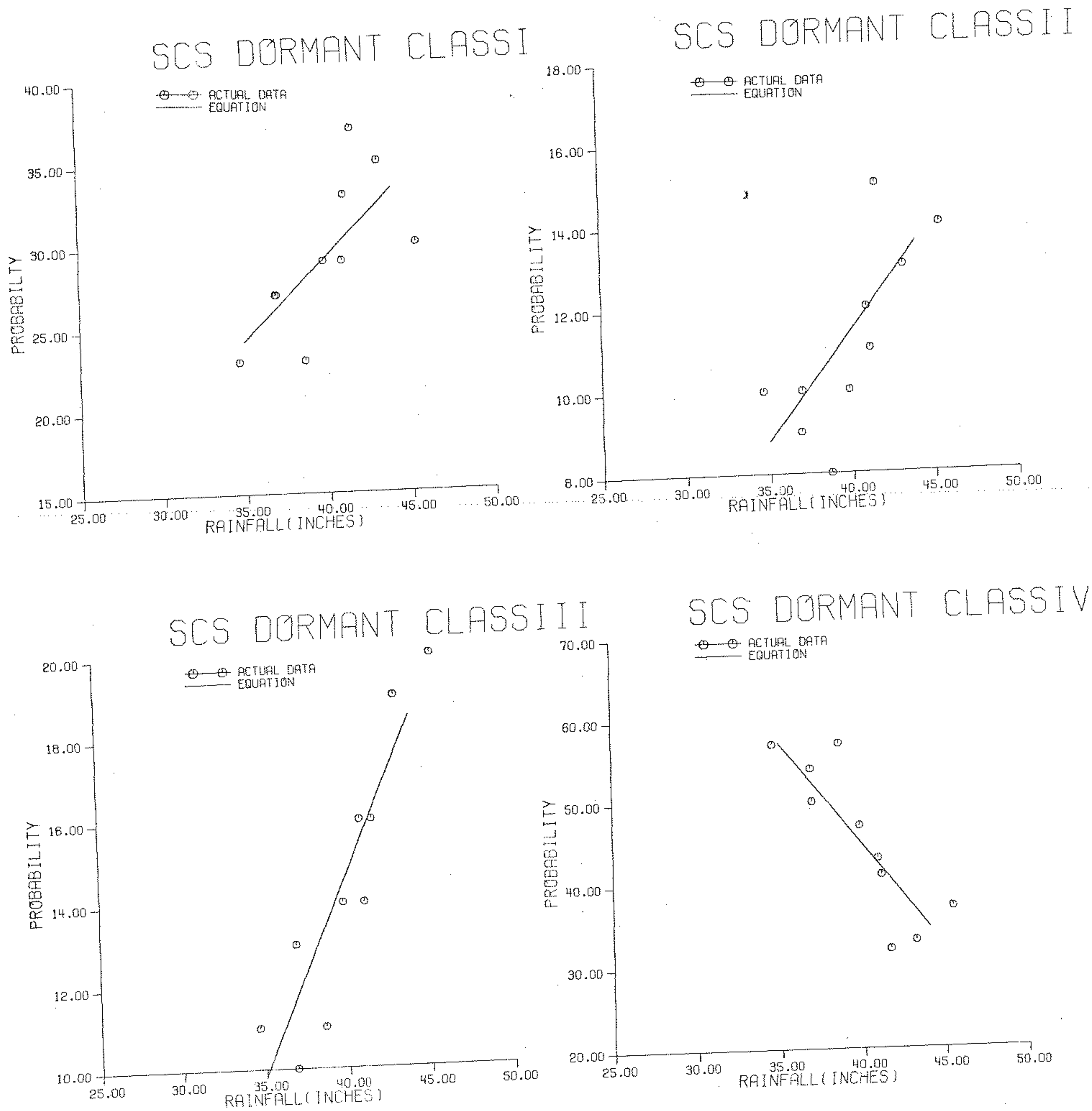



Figure 9. SCS Dormant Season Regression Equations Compared with Data.

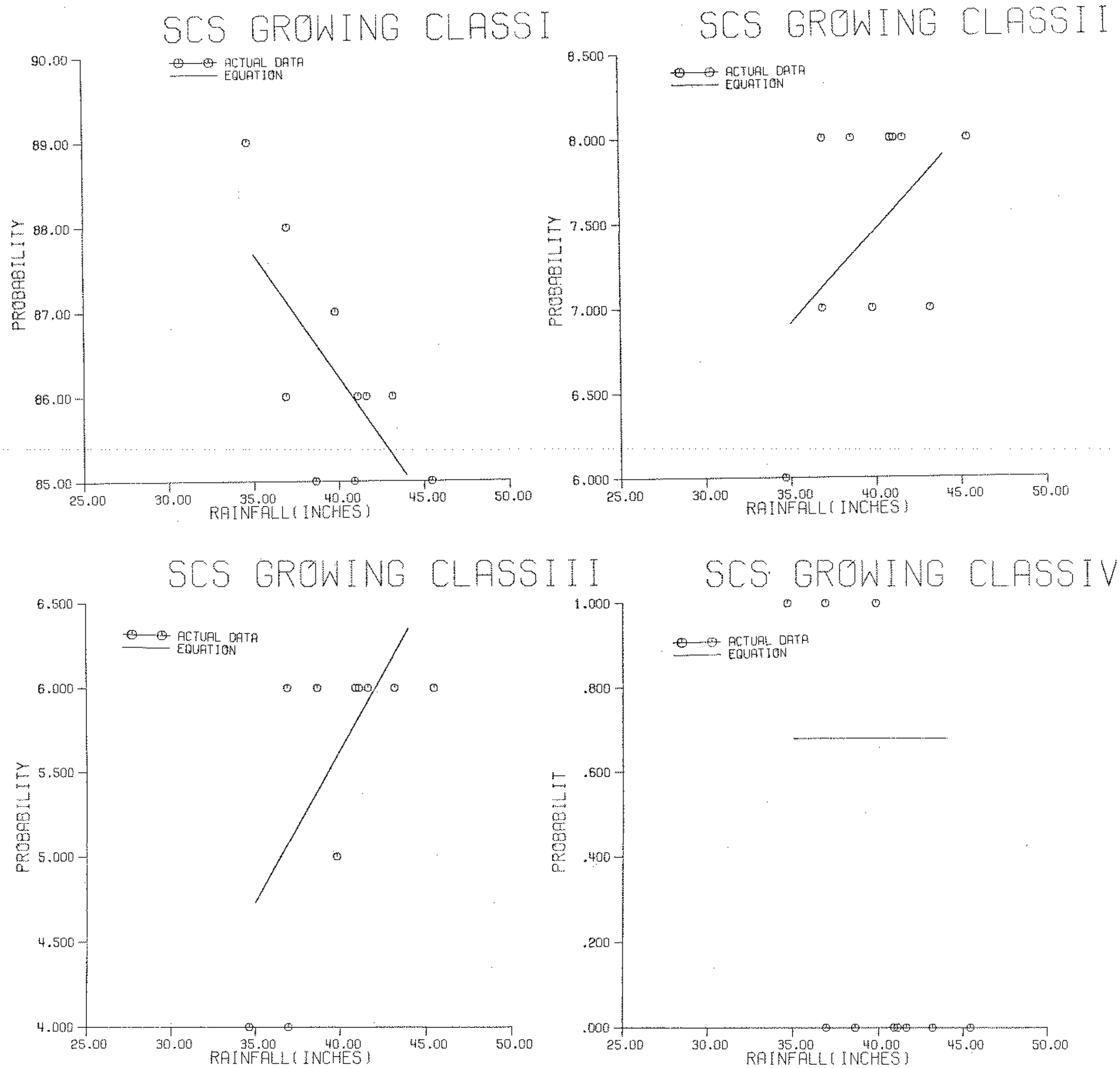



Figure 10. SCS Growing Season Regression Equations Compared with Data.

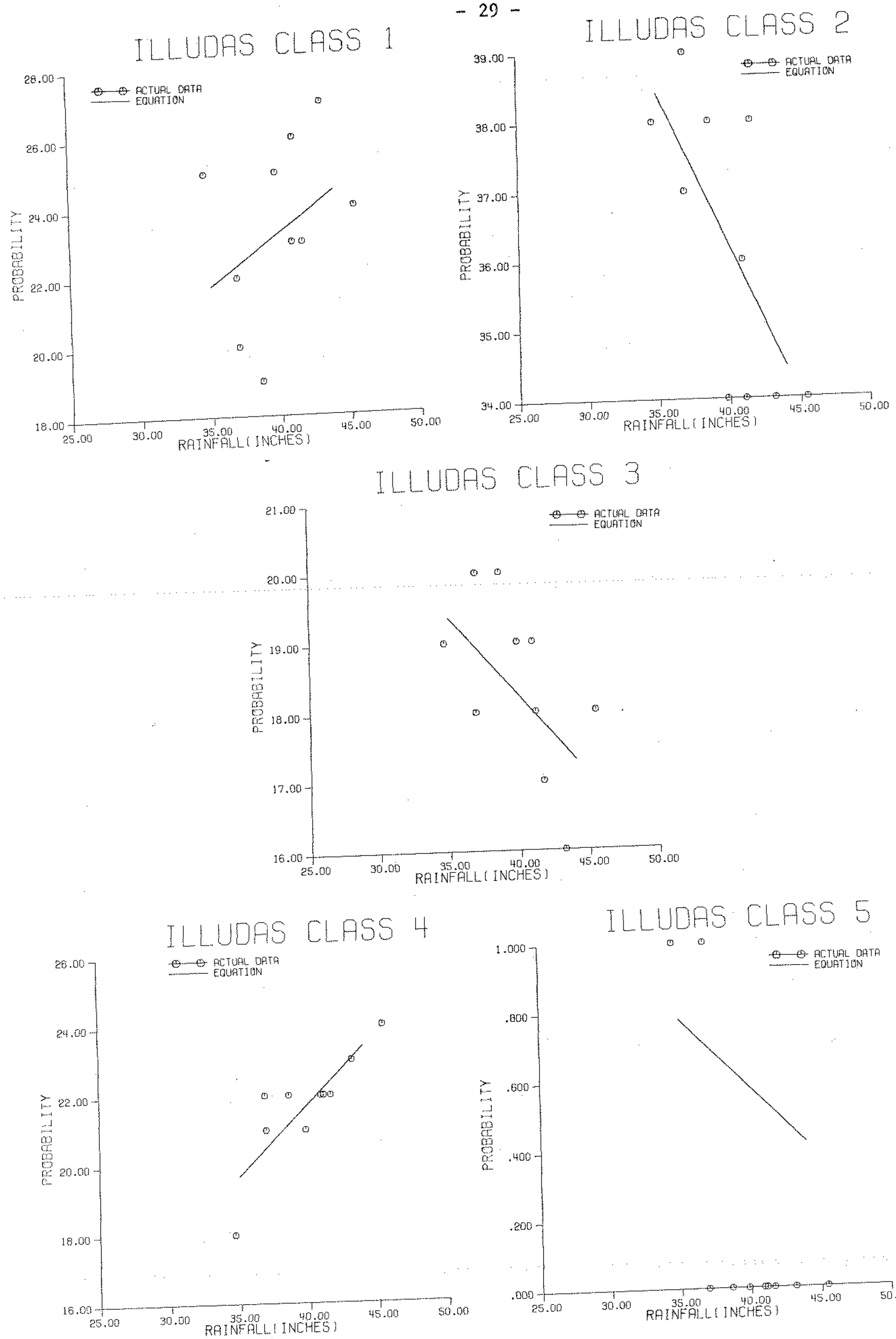



Figure 11. ILLUDAS Regression Equations Compared with Data.

In spite of the reservations expressed in the above paragraph, the equations (7) through (15) exhibit good agreement with similar regression equations found by Gray, Katz, deMonsabert, and Cogo (1982). The latter equations were for the growing season only and were based on 13 stations in the Green River Basin of central Kentucky and Tennessee, 4 stations near Indianapolis, Indiana, and 1 station at West Lafayette, Indiana. Only the last mentioned was common to the two studies. Over the R range from 33 to 55 inches, the maximum discrepancy between equations (7) through (9) and the corresponding SCS growing season equations is 3.1%. The maximum discrepancy between equations (11) through (14) and the corresponding ILLUDAS equations is 4.8% over the same range.

The accuracy of these equations notwithstanding, more accurate results can probably be obtained for locations within Indiana by interpolating the results for the nearest surrounding stations. We therefore recommend interpolation rather than use of equations (3) through (15) for locations in Indiana.

## 3.3. Critique of the Present Methodology

In this report, 5-day antecedent rainfall totals were used to assign each day in the historical records to an AMC class, whether there was rain on that day or not. AMC probabilities were estimated by the relative frequency with which each AMC occurred. In the Discussion of the paper by Gray, Katz, deMonsabert, and Cogo (1982), certain criticisms were leveled at this total series methodology. Both McCuen and Cronshey pointed out that because AMC is relevant only on storm days, the present methodology might be inappropriate and misleading. McCuen further suggested that the AMC probabilities may vary depending on the magnitude of the storm to be simulated. These comments are, in principle, correct. The quantities of interest are the conditional AMC probabilities given that a storm of a certain magnitude occurs. The present scheme calculates unconditioned AMC probabilities.

In order to quantify the actual importance of this theoretical discrepancy, the total series results, based on an analysis of all days, are compared with annual series and partial series results in Table 8. In all cases only the April 1 through October 31 growing seasons were considered. The minimum rain for inclusion in the partial series analysis was 2.00 inches.

One drawback to annual or partial series analysis is the small number of data available. In the case of Berne, the 1948-1977 annual series contains only 30 days and the partial series only 25 days, whereas the total series contains 10,587 days. Nevertheless, the results for the 1910-1977 partial series are remarkably close to the shorter partial series; and all the results are in excellent agreement. The major discrepancy in the SCS results is that the annual and partial series underestimate the total series likelihood of wet conditions by 4%. In the ILLUDAS results, the greatest discrepancy is that the annual series underestimates the total series probability for AMC 1 by 13%. The total series probability for AMC 4 exceeds the others by from 1% to 4%.

At Mount Vernon, the total series results are based on the period from 1948 through 1977 whereas the annual and partial series results are for 1948 through 1973. This discrepancy arose because the unavailability of the 1974 through 1977 data at the time this analysis was performed. The effect on the results should be minimal. The major discrepancy in the SCS results is that the partial series AMC III probability is higher than the total series result by 3%. In the case of the ILLUDAS classifications, the total series gives the highest likelihood of AMC 4, exceeding the annual series by 8%.

The comparison of SCS probabilities for West Lafayette shows a maximum deviation of 10%, the amount the annual series AMC II estimate exceeds the total series result. The total series likelihood of AMC III is underestimated by 6% using the annual series and overestimated by 4% using the partial series. The ILLUDAS partial series underestimates the total series results for AMC 3 by 8% and overestimates the AMC 4 result by 5%.

The small number of data in the annual and partial series makes these results quite volatile compared with the total series, yet it is obvious that all of the methods are in good agreement. At the least, we feel that McCuen's fear that total series analysis may greatly inflate the probability of AMC I and thus underestimate the probability of AMC III can be laid to rest. This conclusion holds specifically for Indiana and should be reevaluated in other regions.

Table 8. Comparison of Present Growing Season AMC Probabilities with Annual and Partial Series Results.

| Station | Berne | | | |
|---|---|---|---|---|
| Period | 1948-77 | 1948-77 | 1948-77 | 1910-77 |
| Method | Total Series | Annual Series | Partial Series | Partial Series |
| SCS I | 88 | 90 | 84 | 86 |
| II | 8 | 10 | 16 | 14 |
| III | 4 | 0 | 0 | 0 |
| IV | 0 | 0 | 0 | 0 |
| ILLUDAS 1 | 20 | 7 | 16 | 18 |
| 2 | 39 | 50 | 40 | 37 |
| 3 | 20 | 27 | 24 | 24 |
| 4 | 21 | 17 | 20 | 20 |
| 5 | 0 | 0 | 0 | 0 |
| **Station** | **Mt. Vernon** | | | |
| Period | 1948-77 | 1948-73 | 1948-73 | |
| Method | Total Series | Annual Series | Partial Series | |
| SCS I | 86 | 88 | 86 | |
| II | 7 | 4 | 5 | |
| III | 6 | 8 | 9 | |
| IV | 0 | 0 | 0 | |
| ILLUDAS 1 | 27 | 23 | 21 | |
| 2 | 34 | 42 | 40 | |
| 3 | 16 | 19 | 19 | |
| 4 | 23 | 15 | 21 | |
| 5 | 0 | 0 | 0 | |
| **Station** | **West Lafayette** | | | |
| Period | 1954-77 | 1954-77 | 1954-77 | |
| Method | Total Series | Annual Series | Partial Series | |
| SCS I | 86 | 83 | 80 | |
| II | 7 | 17 | 10 | |
| III | 6 | 0 | 10 | |
| IV | 1 | 0 | 0 | |

Table 8. Continued

| | | | | |
|---|---|---|---|---|
| ILLUDAS | 1 | 22 | 17 | 23 |
| | 2 | 37 | 38 | 40 |
| | 3 | 18 | 21 | 10 |
| | 4 | 22 | 25 | 27 |
| | 5 | 1 | 0 | 0 |

## 3.4. Cumulative Distribution Functions for 5-Day Antecedent Rainfalls

From time to time, it has been suggested that the AMC class limits be changed or that additional classes be established. These suggestions are explored more fully in Chapter 4. In order to facilitate such a task, 5-day antecedent water equivalent precipitation totals have been tallied in 0.1 inch increments and used to estimate 5-day antecedent precipitation cumulative distribution functions (CDF) for each station. Tables of monthly and annual average results for each station are presented in Appendix 3. The annual CDF for Berne is shown in Figure 12. Monthly CDFs for Berne are shown in Figures 13 and 14. None of these graphs reach a cumulative probability of 1.00 because of missing data or frozen/snow cover days. These factors become increasingly important during the winter months shown in Figure 14.

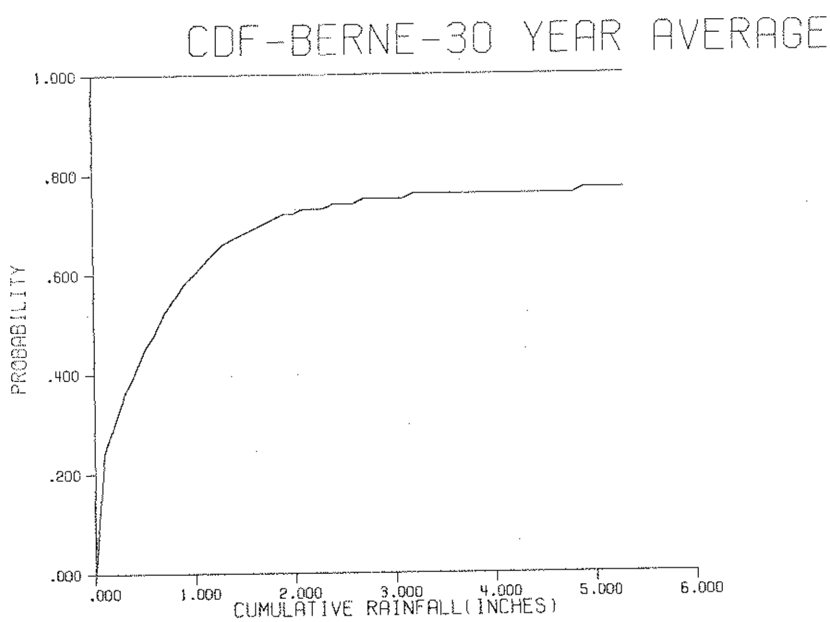



Figure 12. Annual Average 5-Day Antecedent Rainfall Cumulative Distribution Function: Berne, 1948-1977.

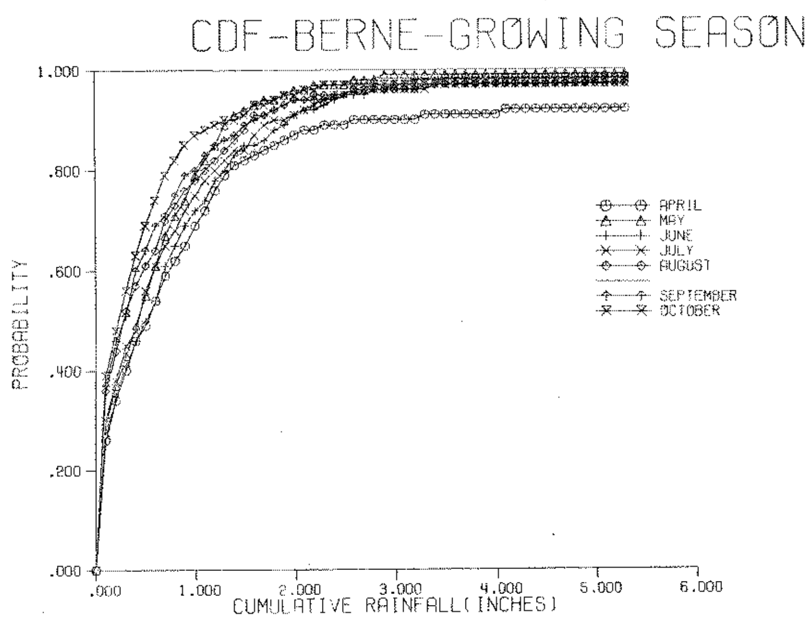



Figure 13. Monthly (Growing Season) 5-Day Antecedent Rainfall Cumulative Distribution Functions: Berne, 1948-1977.

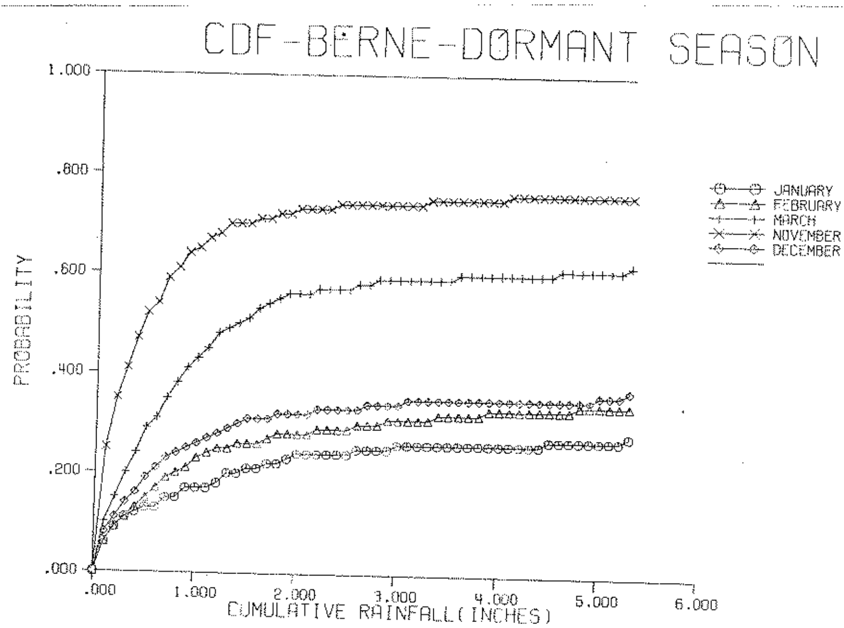



Figure 14. Monthly (Dormant Season) 5-Day Antecedent Rainfall Cumulative Distribution Functions: Berne, 1948-1977.

# Chapter 4

# POTENTIAL MODIFICATIONS OF PRESENT AMC CRITERIA

## 4.1. Limitations of Discrete AMC Classes

Before consideration is given to the prospects for improved criteria for Antecedent Moisture Condition classes, it is well to reexamine the entire concept. Theory, observation, and common senses all support the notion that direct runoff should increase with initial watershed moisture content in most situations. There is every reason to suppose that this relationship is very complex, possibly including discontinuities or hysteretic regions; but there is no reason to think that it is a staircase function, as implied by discrete AMC classes. Discrete classes are merely a convenient approximation which could be improved by establishing a larger number of classes, provided that the necessary experimental data were available.

Another shortcoming of the present schemes is the arbitrary use of the 5-day antecedent period to determine AMC classes. The hypothetical cases in Table 9 illustrate the type of paradox which results. The application of the SCS criteria for day 6 gives AMC II for Case A and AMC I for Case B, even though it is obvious that more runoff would be produced by a storm on day 6 in Case B, other things being equal. It should also be noted that with a fixed antecedent period, time is the only variable assumed to produce drying. Important factors such as air temperature, humidity, wind speed, and hours of sunshine are ignored. Hawkins (1978) proposed a method for calculating a continuously variable CN based on a highly simplified soil moisture accounting scheme. In their Discussion, Rallison and Cronshey of the SCS concluded that Hawkins' method was overly sophisticated in relation to the crude data on which the CN method was based.

Table 9. Illustration of Paradox Caused by 5-Day Antecedent Period.

| Day | Case A Rainfall [inches] | Case B Rainfall [inches] |
|---|---|---|
| 0 | 0 | 4.00 |
| 1 | 1.41 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 1.39 |

One relatively simple way around some of these difficulties is to define a continuously variable Antecedent Precipitation Index (API) in which there are no artificial class boundaries or arbitrarily selected time periods. This parameter has been used mainly in the coaxial graphical method of predicting runoff. Linsley, Kohler, and Paulhus (1982) base the API concept on the assumption that the depletion of soil moisture in a certain period of time is proportional to the soil moisture content at the start of the period. This implies that the moisture remaining in the soil at the end of the time period is also proportional to the initial moisture content. Assuming that the soil moisture content is linearly proportional to the API, this can be expressed in discrete form as

$$API_{i+1} = K \cdot API_i$$

where

API = Antecedent Precipitation Index [inches]
i = time index
K = recession factor, $0 \leq K \leq 1$

Conceptually the API is increased by adding the amount of infiltration resulting from each rainstorm, but sufficient accuracy is usually achieved by adding the total rainfall to the API. The value of K has normally been found to lie between 0.85 and 0.98. Since the depletion of soil moisture is linked to the potential evapotranspiration, K should theoretically vary with the weather and stage of the growing season (Linsley, Kohler, Paulhus, 1982). Unfortunately, the effort required to relate API to runoff parameters such as CN for general applications would be enormous. Since the API scheme would still be a gross approximation, little effort has been directed towards its general implementation.

## 4.2. Upper Bounds for AMC Probabilities

The peculiar fact that rainfall on any day of an antecedent period is equally influential in determining the AMC class on the day following the period allows the calculation of an upper bound for the probability of an AMC class if the total seasonal rainfall R is known. This is because the number of days in a given AMC class is maximized if the available precipitation is divided into rains which just exceed the threshold for that class, spaced at intervals equal to the length of the antecedent period. If the antecedent period is n days, the n day precipitation just sufficient to produce AMC X is $P_x$, the seasonal precipitation is R, and the season is m days long, then the maximum possible number of days d in AMC X is

$$d = n \left(\frac{R}{P_x}\right) \quad \text{where} \quad d \leq n \qquad (16)$$

For example, if it is assumed that the entire average annual precipitation at West Lafayette falls during the 214 day growing season, the maximum number of days in SCS AMC III is

$$d = 5\left(\frac{36.88}{2.11}\right) = 87 \text{ days}$$

This means that no more than 41% of the growing season days could fall into AMC III in an average year. In contrast, up to 184 days or 86% of the growing season could be spent in ILLUDAS AMC 4. Comparison of these percentages with the actual values in Table 5 shows that these bounds are extremely generous.

If it were desired to limit the maximum possible number of days in a redefined AMC X to a particular value, equation (16)) could be solved for the appropriate class limit $P_x$.

## 4.3. Alternative Antecedent Rainfall Limits

From time to time, hydrologists have wondered if the 5-day antecedent rainfall limits used in the Curve Number method or in ILLUDAS should be modified. Most recently, Hawkins (Discussion of Gray, Katz, deMonsabert, and Cogo, 1982) has suggested that local adjustment of the SCS criteria might be desirable. The information needed to perform such adjustments in Indiana is provided by the cumulative distribution functions for 5-day antecedent precipitation in Appendix 3.

As an illustration of what can be done, Table 10 lists the 90th percentile 5-day antecedent precipitation totals for each station by month and by season. In establishing these totals, bad data and frozen or snow covered days have been deleted. Table 10 reveals that the 90th percentile totals vary considerably from month to month, and across Indiana during each month. The variation is much greater during the dormant season than during the growing season. It is interesting to note that in most cases the growing season values are considerably smaller than the dormant season values. The Indiana average values are 1.6 inches for the growing season and 2.0 inches for the dormant season. The SCS AMC class limits are higher during the growing season, probably because of the higher values of potential evapotranspiration during the summer.

Table 10. 90th Percentile 5-Day Antecedent Rainfalls [inches]

a) Dormant Season

| Station | Jan. | Feb. | March | Nov. | Dec. | Average | High | Low |
|---|---|---|---|---|---|---|---|---|
| Berne | 2.5 | 2.6 | 1.9 | 1.2 | 2.2 | 2.1 | 2.6 | 1.2 |
| Mt. Vernon | 2.5 | 2.3 | 2.3 | 1.5 | 1.7 | 2.1 | 2.5 | 1.5 |
| Paoli | 2.9 | 2.35 | 2.1 | 1.6 | 2.0 | 2.2 | 2.9 | 1.6 |
| Rockville | 2.6 | 1.9 | 1.6 | 1.4 | 2.0 | 1.9 | 2.6 | 1.4 |
| Rushville | 2.4 | 2.2 | 1.8 | 1.25 | 1.7 | 1.9 | 2.4 | 1.25 |
| Spencer | 2.6 | 1.9 | 1.95 | 1.6 | 2.0 | 2.0 | 2.6 | 1.6 |
| Valparaiso | 3.3 | 2.7 | 1.7 | 1.3 | 2.2 | 2.2 | 3.3 | 1.3 |
| Vevay | 2.1 | 2.5 | 2.0 | 1.25 | 1.5 | 1.9 | 2.5 | 1.25 |
| Waterloo | 2.4 | 1.9 | 1.4 | 1.3 | 2.3 | 1.9 | 2.4 | 1.3 |
| West Lafayette | 2.7 | 1.5 | 1.4 | 1.2 | 1.7 | 1.7 | 2.7 | 1.2 |
| Average | 2.6 | 2.2 | 1.8 | 1.4 | 1.9 | 2.0 | | |
| High | 3.3 | 2.7 | 2.3 | 1.6 | 2.3 | 2.2 | | |
| Low | 2.1 | 1.5 | 1.4 | 1.2 | 1.5 | 1.7 | | |

b) Growing Season

| Station | Apr. | May | June | July | Aug. | Sept. | Oct. | Average | High | Low |
|---|---|---|---|---|---|---|---|---|---|---|
| Berne | 1.5 | 1.3 | 1.9 | 1.6 | 1.45 | 1.55 | 1.1 | 1.5 | 1.9 | 1.1 |
| Mt. Vernon | 1.6 | 1.9 | 1.7 | 1.7 | 1.7 | 1.4 | 1.3 | 1.6 | 1.9 | 1.3 |
| Paoli | 1.8 | 1.65 | 2.05 | 1.85 | 1.6 | 1.5 | 1.35 | 1.7 | 2.05 | 1.35 |
| Rockville | 1.7 | 1.5 | 1.9 | 1.8 | 1.5 | 1.4 | 1.2 | 1.6 | 1.9 | 1.2 |
| Rushville | 1.5 | 1.65 | 1.6 | 1.9 | 1.5 | 1.4 | 1.2 | 1.5 | 1.9 | 1.2 |
| Spencer | 1.6 | 1.65 | 2.2 | 1.8 | 1.7 | 1.6 | 1.2 | 1.7 | 2.2 | 1.2 |
| Valparaiso | 1.7 | 1.6 | 1.8 | 1.55 | 1.6 | 1.7 | 1.5 | 1.6 | 1.8 | 1.5 |
| Vevay | 1.75 | 1.55 | 1.8 | 1.65 | 1.55 | 1.6 | 1.45 | 1.6 | 1.8 | 1.45 |
| Waterloo | 1.35 | 1.35 | 1.5 | 1.5 | 1.4 | 1.3 | 1.25 | 1.4 | 1.5 | 1.25 |
| West Lafayette | 1.6 | 1.6 | 1.85 | 1.8 | 1.6 | 1.6 | 1.3 | 1.6 | 1.85 | 1.3 |
| Average | 1.6 | 1.6 | 1.8 | 1.7 | 1.6 | 1.5 | 1.3 | 1.6 | | |
| High | 1.8 | 1.9 | 2.2 | 1.9 | 1.7 | 1.7 | 1.5 | 1.7 | | |
| Low | 1.35 | 1.35 | 1.5 | 1.5 | 1.4 | 1.3 | 1.1 | 1.4 | | |

## 4.4. Alternate Antecedent Periods

The use of a 5-day antecedent period for the determination of AMC has no theoretical basis. Mockus (1972, page 4.10) mentions that antecedent periods of 5 to 30 days or more have sometimes been used as indices of watershed wetness. In order to investigate the effect of other antecedent periods, the Berne data from 1948 through 1977 were reanalyzed for antecedent periods of 4, 6, 7, 15, and 30 days.

Table 11 presents the results of these calculations. As would be expected, lengthening the antecedent period increases the likelihood of the higher AMC classes. In the 4 to 7 day range, the variation is approximately linear. It should also be noted that as the antecedent period increases, the number of days excluded from the computations by a single missing measurement increases dramatically.

Although one can imagine schemes in which the length of the antecedent period is made to vary depending on temperature, windspeed, or hours of sunshine, they do not seem to be practical. If a single antecedent period is to be used, the 5-day period seems to be as good as any. The authors find no general advantage in choosing other antecedent periods and do not recommend the practice.

Table 11. Sensitivity of AMC Percentage Probabilities to Antecedent Period Length: Berne, Indiana (1948-1977).

| Antecedent Period Length (Days) | Percentage Probabilities | | | | | | | | | | | | | Percentage Excluded Days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCS Dormant Season | | | | SCS Growing Season | | | | ILLUDAS (Growing Season) | | | | | |
| | I | II | III | IV | I | II | III | IV | 1 | 2 | 3 | 4 | 5 | |
| 4 | 31 | 9 | 10 | 50 | 91 | 6 | 3 | 0 | 27 | 39 | 18 | 16 | 0 | 3 |
| 5 | 27 | 10 | 13 | 50 | 88 | 8 | 4 | 0 | 20 | 39 | 20 | 21 | 0 | 3 |
| 6 | 23 | 10 | 16 | 50 | 84 | 9 | 6 | 0 | 14 | 37 | 21 | 27 | 0 | 4 |
| 7 | 20 | 11 | 20 | 50 | 80 | 11 | 8 | 0 | 11 | 35 | 22 | 32 | 0 | - |
| 15 | 2 | 9 | 38 | 50 | 37 | 31 | 33 | 0 | 1 | 7 | 18 | 73 | 0 | 6 |
| 30 | 0 | 1 | 50 | 50 | 6 | 8 | 86 | 0 | 0 | 0 | 0 | 2 | 98 | 10 |

## Chapter 5

## SUMMATION

Discrete Antecedent Moisture Condition classes, although conceptually unsatisfactory, are the simplest means to account for the effect of initial watershed wetness on runoff. Two of the most widely used hydrologic models - the SCS Curve Number method and the ILLUDAS program - use AMC schemes. In the past, there has not been much quantitative information available to guide the selection of an appropriate AMC class for design calculations with these models. This report presents reliable estimates of the likelihood of each AMC class in Indiana. This establishes the basis for a more rational choice, and enables Indiana hydrologists to use these models with greater insight, confidence, and precision.

A total of 258 years of daily meteorological observations at 10 Indiana stations was analyzed to estimate the occurrence probabilities for Curve Number and ILLUDAS AMC classes. Both seasonal and monthly results have been reported. The relative uniformity of the probabilities among the stations means that probabilities for any location in Indiana can be interpolated with confidence. During the growing season, the probability of SCS AMC I is greater than 85% at every station. In sharp contrast, the probabilities of the ILLUDAS AMC classes are much more even. During the dormant season, frozen or snow covered ground has a statewide average probability of 46%. The authors believe that these findings will be useful to practicing hydrologists and drainage engineers in Indiana and recommend that AMC occurrence probabilities be calculated for other regions. Before adopting the total series methodology used in this report, researchers should carefully consider Section 3.3 because the same approach may not be valid in other climates.

Future researchers may wish to redefine the present AMC criteria. This is especially true of the SCS criteria whose relationship to the original runoff experiments is murky. The Cumulative Distribution Functions for 5-day antecedent rainfalls presented in Appendix 3 should allow this to be done without having to reanalyze the original data.

## ACKNOWLEDGEMENTS

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```
C       STA=THE STAION NUMBER
C
C       ELE=ELEMENT TYPE(MAXT,MINT,RAIN,SNOW,ETC)
C       FLAG1=FLAG TELLING IF THE OBSERVATIONS HAVE BEEN MODIFIED
C       YEAR=THE YEAR FOR THE OBSERVATIONS
C       MONT=THE MONTH OF THE OBSERVATIONS
C       NUMB=THE NUMBER OF DATA POINTS WHICH ARE TO FOLLOW
C      OBS=THE OBSERVATIONS WHICH FOLLOW
C      FLAG2=A FLAG TELLING THAT A TRACE WAS RECORDED
C      DATE=THE DATE OF THE OBSERVATION
C
C*********************************************************
C
C
C  CHECK TO SEE IF THE STATION IS THE ONE OF INTEREST
C  OR IF THE YEAR THAT IS BEING ANALYZED HAS BEEN READ IN
C  IN ITS ENTIRETY
      IF(STA.LT.STAT)GOTO 3
      IF(STA.GT.STAT)GOTO 999
C     IF(YEAR.GT.NYEARE)GOTO 999
      IF(YEAR.GT.NYEAR)GOTO 70
      IF(YEAR.LT.NYEAR)GOTO 3
C
C
C*********************************************************
C
C  IF THIS IS THE FIRST TIME THROUGH THE PROGRAM OR IF ANOTHER
C  YEAR IS TO BE ANALYZED, SET EVERYTHING TO ZERO
C
C
C     IF(NN.NE.0)GOTO 69
 9    IF(MFLAG.EQ.1)THEN
      MFLAG=1
      ELSE
      GOTO 11
      ENDIF
      DO 12 K=1,53
      DO 12 I=1,12
      M1TT(I)=M2TT(I)=M3TT(I)=M4TT(I)=M5TT(I)=M6TT(I)=M7TT(I)=
     *M8TT(I)=M9TT(I)=M10TT(I)=M11TT(I)=M12TT(I)=M13TT(I)=M14TT(I)=
     *L(I)=M15TT(I)=0
      MLS=MMS=M14TTT=MBADDTT=MBADGTT=0
 12   MMT(K,I)=0
 11   DO 66 I=1,12
      MSCS1D(I)=MSCS1G(I)=MSCS2G(I)=MSCS2D(I)=MSCS3G(I)=
     :MSCS3D(I)=MSCS4G(I)=MSCS4D(I)=MILL1(I)=MILL2(I)=MILL3(I)=
     *MILL4(I)=MILL5(I)=L(I)=MBAD(I)=0
      Q1(I)=Q2(I)=Q3(I)=Q4(I)=Q5(I)=
     *Q6(I)=Q7(I)=Q8(I)=Q9(I)=Q10(I)=Q11(I)=Q12(I)=Q13(I)=
     *R1(I)=R2(I)=R3(I)=R4(I)=R5(I)=R6(I)=R7(I)=R8(I)=R9(I)=
     *R10(I)=R11(I)=R12(I)=R13(I)=R15(I)=Q15(I)=0.0
 66    QL(I)=RL(I)=R14(I)=Q14(I)=QM(I)=RM(I)=0.0
      NNFLAG=0
      MBADD=MBADG=0
       DO 68 K=1,53
      DO 68 I=1,12
      N(K,I)=NS(K)=0
      QS(K)=RS(K)=R(K,I)=Q(K,I)=0.0
 68   CONTINUE
C
C
C
C  NOW TAKE THE OBSERVED VALUES AND PUT THEM IN THE PROPER ARRAYS
C
C
 69   IF(ELE.EQ.≠TMAX≠)GOTO 20
      IF(ELE.EQ.≠TMIN≠)GOTO 30
      IF(ELE.EQ.≠PRCP≠)GOTO 40
C     IF(ELE.EQ.≠SNOW≠)GOTO 45
      IF(ELE.EQ.≠SNWD≠)GOTO 50
C
C*********************************************************
C        TMAX=THE MAXIMUM OBSERVED TEMPERATURE
C        TMIN=THE MINIMUM OBSERVED TEMPERATURE
C        PRCP=THE MEASURED RAINFALL
C        SNOW=THE MEASURED SNOWFALL
C        SNWD=THE MEASURED SNOW ON THE GROUND
C
C*********************************************************
```

```
C
C  IF THE YEAR IS NOT THE ONE THAT IS DESIRED SET THE
C  OBSERVED VALUES TO ZERO
      GOTO 60
 15   DO 16 I=1,NUMB
 16   OBS(I)=0
      GOTO 60
C*****************************************************
C     THE FOLLOWING PUTS THE OBSERVATIONS IN THE CORRECT ARRAYS
C
C*****************************************************
 20   DO 21 I=1,NUMB
 21   MAXT(MONTH,DATE(I))=OBS(I)
      GOTO 60
 30   DO 31 I=1,NUMB
 31   MINT(MONTH,DATE(I))=OBS(I)
      GOTO 60
 40   DO 41 I=1,NUMB
      IF(FLAG2(I).EQ.≠T≠)THEN
      PRCP(MONTH,DATE(I))=OBS(I)
      PRCP(MONTH,DATE(I))=0.00
      ENDIF
      PRCP(MONTH,DATE(I))=OBS(I)
 41   IF(FLAG1.EQ.≠H≠)PRCP(MONTH,DATE(I))=PRCP(MONTH,DATE(I))*0.01
      GOTO 60
C45   DO 46 I=1,NUMB
C     IF(FLAG2(I).EQ.≠T≠)OBS(I)=0.0
C     SNOW(MONTH,DATE(I))=OBS(I)
C46   IF(FLAG1.EQ.≠T≠)SNOW(MONTH,I)=SNOW(MONTH,I)*0.1
C     GOTO 60
 50   DO 51 I=1,NUMB
 51   SNOWD(MONTH,DATE(I))=OBS(I)
 60   GOTO 3
 70   CONTINUE
C*****************************************************
C
C PRINT OUT THE YEAR AND THE MONTHS
C
      NYEAR=NYEAR+1
      MYEAR=YEAR-1
      WRITE(6,101)MYEAR
 101  FORMAT(2X,≠YEAR=≠,I4)
      WRITE(6,102)
 102  FORMAT(6X,≠JANUARY≠,2X,≠FEBRUARY≠,3X,≠MARCH≠,5X,≠APRIL≠,
     *4X,≠MAY≠,4X,≠JUNE≠,5X,≠JULY≠,4X,≠AUGUST≠,2X,≠SEPTEMBER≠,
     *1X,≠OCTOBER≠,1X,≠NOVEMBER≠,2X,≠DECEMBER≠,4X,≠**TOTALS**≠)
C
C*****************************************************
C
C     THIS IS THE SECTION OF THE PROGRAM WHICH TAKES THE
C     DATA AND SEPERATES IT INTO BOTH INTERVALS AND AMC CLASSES
C*****************************************************
C
C
       DO 200 I=1,12
       DO 200 J=1,31
C
C      THROW OUT DAYS WHICH DO NOT OCCUR
C
      IF(I.EQ.2.AND.J.GE.30)GOTO 200
      IF(I.EQ.4.AND.J.EQ.31)GOTO 200
      IF(I.EQ.6.AND.J.EQ.31)GOTO 200
      IF(I.EQ.9.AND.J.EQ.31)GOTO 200
      IF(I.EQ.11.AND.J.EQ.31)GOTO 200
      IF(I.EQ.2.AND.J.EQ.29)GOTO 65
      GOTO 250
C*****************************************************
C      THE FOLLOWING TESTS FOR LEAP YEAR
C*****************************************************
C  NYEAR=THE YEAR WHICH IS CURRENTLY BEING ANALYZED
C  YEAR=THE YEAR THAT IS READ FROM THE TAPE
C  NYEARE=THE LAST YEAR THAT IS DESIRED
C  LYEAR=AN ARRAY WHICH CONTAINS ALL LEAP YEARS
C  MYEAR=IS THE YEAR WHICH WAS JUST READ IN
 65    LYEAR(1)=1896
      DO 67 K=2,23
      IF(LYEAR(K-1).EQ.MYEAR)THEN
      MONTHS(2)=29
      NLEAP=1
      GOTO 250
```

```
      ENDIF
      LYEAR(K)=LYEAR(K-1)+4
      IF(LYEAR(K).GT.MYEAR)THEN
      MONTHS(2)=28
      NLEAP=0
      GOTO 200
      ENDIF
 67   CONTINUE
C
C
C**************************************************
C  NN=A POINTER INDICATING THE NUMBER OF DAYS WHICH HAVE
C  BEEN ANALYZED FOR THIS STATION TO DATE
C
C**************************************************
C
 250  NN=NN+1
      IF(MYEAR.EQ.1948.AND.NN.EQ.6.AND.I.EQ.1)THEN
      IF(LFLAG.EQ.0)MBAD(1)=MBAD(1)+5
      IF(MBAD(1).GT.31)MBAD(1)=31
      ELSE
      ENDIF
      IF(MAXT(I,J).EQ.200.OR.MINT(I,J).EQ.200.OR
     *.SNOWD(I,J).EQ.200.0)THEN
      IF(NN.LE.6.AND.LFLAG.NE.2)LEFT=NN-1
      IF(LFLAG.EQ.0)LEFT=0
      MBAD(I)=MBAD(I)+LEFT+1
      IF(I.LT.4.OR.I.GT.10)THEN
      MBADD=MBADD+1+LEFT
      ELSE
      MBADG=MBADG+1+LEFT
      ENDIF
      LFLAG=1
      LEFT=0
      NN=0
      STORE=0.0
      GOTO 200
      ELSE
      ENDIF
C
C**************************************************
C
C MTAVE IS THE AVERAGE TEMPERATURE FOR THE DAY
C
      MTAVE(I,J)=(MAXT(I,J)+MINT(I,J))*0.5
C
C**************************************************
C**************************************************
C   THE STATEMENT BELOW CHECKS TO SEE IF THE DAY FALLS
C   INTO SCS CLASS 4 OR ILLUDAS CLASS 5 .  THIS WIIL OCCUR
C  WHENEVER THE TEMPERATURE FALLS BELOW 32 OR WHEN THERE
C  IS SNOW ON THE GROUND.
C
      IF(LFLAG.EQ.1.AND.MONTHS(I).EQ.J)THEN
      MBAD(I)=MBAD(I)+NN
      IF(I.LT.4.OR.I.GT.10)THEN
      MBADD=MBADD+NN
      ELSE
      MBADG=MBADG+NN
      ENDIF
      LFLAG=2
      LEFT=5-NN
      ELSE
      ENDIF
C     IF(NN.LE.5)GOTO 200
C     IF(MTAVE(I,J).LE.32.OR.SNOWD(I,J).GT.0.0) GOTO 500
C
C
C**************************************************
C
C   NOW SUM UP THE AMOUNT OF RAIN THAT HAS FALLEN TO DATE THIS
C  YEAR
C
C
C**************************************************
        COUNT(NN-1)=COUNT(NN-1)+STORE
      COUNT(NN)=COUNT(NN-1)+PRCP(I,J)
      IF(NN.LE.5)GOTO 200
C
C  COUNT(NN)=THE CUMULATIVE MOISTURE WHICH HAS FALLEN
```

```
C  TO DATE
C
      IF(LFLAG.EQ.2)THEN
      MBAD(I)=MBAD(I)+LEFT
      IF(I.LT.4.OR.I.GT.10)THEN
      MBADD=MBADD+LEFT
      ELSE
      MBADG=MBADG+LEFT
      ENDIF
      LEFT=0
      LFLAG=0
      ELSE
      ENDIF
      IF(LFLAG.EQ.1)THEN
      MBAD(I)=MBAD(I)+5
      IF(I.LT.4.OR.I.GT.10)THEN
      MBADD=MBADD+5
      ELSE
      MBADG=MBADG+5
      ENDIF

      LFLAG=0
      ELSE
      ENDIF
      IF(MTAVE(I,J).LE.32.OR.SNOWD(I,J).GT.0.0)GOTO 500
C*****************************************************
C
C     CALCULATE THE 5 DAY ANTECEDENT MOISTURE
      AM(I,J)=COUNT(NN-1)-COUNT(NN-6)
C
C  AM=THE ANTECEDENT MOISTURE FOR THE DAY CORRESPONDING
C  TO MONTH I AND DAY J
C
C
C*****************************************************
C     NOW SET THE STORAGE BACK TO ZERO
      STORE=0.0
C
C*****************************************************
C
C
C      NOW SEPERATE THE AMC INTO 0.1 INCH INCREMENTS
C
C
C*****************************************************
C
C  FIRST SET THE MONTHS ARRAY-- THE NUMBER OF DAYS IN EACH MONTH
C
      MONTHS(4)=30
      MONTHS(1)=31
      MONTHS(3)=31
      MONTHS(5)=31
      MONTHS(6)=30
      MONTHS(7)=31
      MONTHS(8)=31
      MONTHS(9)=30
      MONTHS(10)=31
      MONTHS(11)=30
       MONTHS(12)=31
C
C
C
C  TEST TO FIND WHICH INTERVAL THAT IT FALLS IN.
C  THE ARRAY N(K,I) CORRESPONDS TO THE NUMBER OF OCCURENCES
C  FOR THE INTERVAL K IN MONTH I.  EACH INTERVAL K IS
C  FOR AN INCREMENT  K-1< AM < K*.1 . S(K) IS THE VALUE
C  OF THE INTERVAL UPPER LIMIT
      IF(AM(I,J).EQ.0.00)THEN
      N(1,I)=N(1,I)+1
      GOTO 299
      ENDIF
      S(1)=0.099
      DO 289 K=2,54
      IF(AM(I,J).LT.S(K-1))THEN
      N(K-1,I)=N(K-1,I)+1
C
C
C  IF AM FALLS IN THE ABOVE INTERVAL, SELECT THE AMC LEVEL
C
C
```

```
      IF(S(K-1).LT.0.5)GOTO 400
      IF(S(K-1).LT.1.0)GOTO 401
      IF(S(K-1).LT.1.1)GOTO 402
      IF(S(K-1).LT.1.4)GOTO 403
      IF(S(K-1).LT.2.1)GOTO 404
      IF(S(K-1).GE.2.1)GOTO 405
      ELSE
      S(K)=S(K-1)+0.1
      ENDIF
C
C
 289   CONTINUE
      N(53,I)=N(53,I)+1
      GOTO 405
C
C
C*****************************************************
C MSCS1D=THE → OF OCC. FOR SCS AMC CLASS 1 DORMANT SEASON
C MSCS2D=THE → OF OCC. FOR SCS AMC CLASS 2 DORMANT SEASON
C MSCS3D=THE → OF OCC. FOR SCS AMC CLASS 3 DORMANT SEASON
C MSCS4D=THE → OF OCC. FOR SCS AMC CLASS 4 DORMATN SEASON
C MSCS1G=THE → OF OCC. FOR SCS AMC CLASS 1 GROWING SEASON
C MSCS2G=THE → OF OCC. FOR SCS AMC CLASS 2 GROWING SEASON
C MSCS3G=THE → OF OCC. FOR SCS AMC CLASS 3 GROWING SEASON
C MSCS4G=THE → OF OCC. FOR SCS AMC CLASS 4 GROWING SEASON
C MILL1=THE → OF OCC. FOR ILLUDAS AMC CLASS 1
C MILL2=THE → OF OCC. FOR ILLUDAS AMC CLASS 2
C MILL3=THE → OF OCC. FOR ILLUDAS AMC CLASS 3
C MILL4=THE → OF OCC. FOR ILLUDAS AMC CLASS 4
C MILL5=THE → OF OCC. FOR ILLUDAS AMC CLASS 5
C
C*****************************************************
C*****************************************************
C
 400   IF(I.LT.4.OR.I.GT.10)THEN
      MSCS1D(I)=MSCS1D(I)+1
      ELSE
      MSCS1G(I)=MSCS1G(I)+1
      MILL2(I)=MILL2(I)+1
      ENDIF
      GOTO 200
 299  IF(I.LT.4.OR.I.GT.10)THEN
      MSCS1D(I)=MSCS1D(I)+1
       ELSE
      MSCS1G(I)=MSCS1G(I)+1
      MILL1(I)=MILL1(I)+1
      ENDIF
      GOTO 200
 401  IF(I.LT.4.OR.I.GT.10)THEN
      MSCS2D(I)=MSCS2D(I)+1
      ELSE
      MSCS1G(I)=MSCS1G(I)+1
      MILL3(I)=MILL3(I)+1
      ENDIF
      GOTO 200
 402    IF(I.LT.4.OR.I.GT.10)THEN
      MSCS3D(I)=MSCS3D(I)+1
      ELSE
      MSCS1G(I)=MSCS1G(I)+1
      MILL4(I)=MILL4(I)+1
      ENDIF
      GOTO 200
 403  IF(I.LT.4.OR.I.GT.10)THEN
      MSCS3D(I)=MSCS3D(I)+1
      ELSE
      MSCS1G(I)=MSCS1G(I)+1
      MILL4(I)=MILL4(I)+1
      ENDIF
      GOTO 200
 404  IF(I.LT.4.OR.I.GT.10)THEN
      MSCS3D(I)=MSCS3D(I)+1
      ELSE
      MSCS2G(I)=MSCS2G(I)+1
      MILL4(I)=MILL4(I)+1
      ENDIF
      GOTO 200
 405  IF(I.LT.4.OR.I.GT.10)
      MSCS3D(I)=MSCS3D(I)+1
      ELSE
      MSCS3G(I)=MSCS3G(I)+1
```

```
      MILL4(I)=MILL4(I)+1
      ENDIF
      GOTO 200
 500  IF(I.LT.4.OR.I.GT.10)THEN
      MSCS4D(I)=MSCS4D(I)+1
      ELSE
      MSCS4G(I)=MSCS4G(I)+1
      MILL5(I)=MILL5(I)+1
      ENDIF
C     THE VALUE BELOW STORES THE WATER EQUIVALENT OF THE
C     SNOW WHICH HAS FALLEN.  THIS WILL BE ACCOUNTED FOR
C     ON THE FIRST DAY THE TEMP IS GREATER THAN 32 DEGREES
C
C
      STORE=STORE+PRCP(I,J)
      COUNT(NN)=COUNT(NN-1)
       L(I)=L(I)+1
C
C  L(I)=THE NUMBER OF TIMES THAT A FROZEN SOIL CONDITION
C  OCCURS IN MONTH I.  THIS IS DESIGNATED AS P00 IN TH OUTPUT
C
C
C
C
 200  CONTINUE
C
C
C      THE NEXT PORTION WILL TAKE THE YEARLY SUM OF THE
C      AMC CLASSES
C
C
C
C    THIS FIRST SEGMENT TAKES INTO ACCOUNT,IN A SEPERATE
C    INTERVAL, THE DAYS IN WHICH THE AVE AIR TEMP IS LESS
C    THAN 32 DEGREES OR THERE IS SNOW ON THE GROUND
C*****************************************************
C
C MLS=THE TOTAL NUMBER OF OCCURENCES IN THE YEAR OF FROZEN SOIL
C MMS=THE TOTAL NUMBER OF OCCURENCES OF NO OBSERVATIONS
C QL(I)=THE PROBABILITY OF THE FROZEN CONDITION OCCURING FOR MONTH I
C RL(I)=CUM. PROBABILTY OF THE FROZEN CONDITION OCCURING FOR MONTH I
C RLS=THE PROBABILITY OF THE FROZEN CONDITON OCCURING FOR THE YEAR
C QLS=THE CUM PROBABILTY OF THE FROZEN CONDITION OCCURING FOR YEAR
C
C*****************************************************
C
        MLS=0
      MMS=0
      DO 530 I=1,12
      NDAYS=365+NLEAP
      V=FLOAT(L(I))
      X=FLOAT(MONTHS(I))
      A=FLOAT(MBAD(I))
      QM(I)=A/X
      RM(I)=QM(I)
      QL(I)=V/X
      RL(I)=QL(I)+RM(I)
      MMS=MMS+MBAD(I)
      WRITE(6,529)MMS
 529  FORMAT(5X,≠MMS=≠,I5)
 530  MLS=MLS+L(I)
      W=FLOAT(MLS)
      V=FLOAT(NDAYS)
      B=FLOAT(MMS)
      QMS=B/V
      RMS=QMS
      QLS=W/V
      RLS=QLS+RMS
      NSS=0
C
C*****************************************************
C
C THE FOLLWING SECTION CALCULATES THE TOTALS NUMBER OF OCCURANCES,
C THE PROBABILITY, AND CUMULATIVE PROBABILITY FOR EACH 0.1 INCH
C INCREMENT AND AMC CLASS
C
*****************************************************
C
C THE VARIABLES USED ARE DEFINED BELOW
C M1 THROUGH ARE THE M13 ARE THE TOTAL NUMBER OF OCCURENCES OF THE
```

```
C AMC CLASSES IN THE ORDER PREVIOSLY DESCRIBED
C RES=THE VALUE OF PROBABILTIY FOR THE FROZEN SOIL FOR THE MONTH
C RESS THE=THE VALUE OF CUM PROB FOR THE FROZEN SOIL FOR THE MONTH
C Q(K,I)=THE PROBABILITY OF THE ANTECEDENT MOISTURE FALLING
C         IN INTERVAL K FOR THE MONTH I
C R(K,I)=THE CUM PROBABILTY OF THE ANTECEDENT MOISTURE FALLING
C         IN INTERVAL K FOR MONTH I
C
C
C*****************************************************
      DO 550 K=1,53
      DO 540 I=1,12
      NDAYS=365+NLEAP

      Y=FLOAT(N(K,I))
      X=FLOAT(MONTHS(I))
      Q(K,I)=Y/X
      IF(K.EQ.1)THEN
      RES=RL(I)
      ELSE
      RES=0.0
      ENDIF
      R(K,I)=Q(K,I)+R(K-1,I)+RES
 540  NSS=N(K,I)+NSS
      NS(K)=NSS
      Z=FLOAT(NS(K))
      V=FLOAT(NDAYS)
      NSS=0
      QS(K)=Z/V
      IF(K.EQ.1)THEN
      RESS=RLS
      ELSE
      RESS=0.0
      ENDIF
 550  RS(K)=QS(K)+RS(K-1)+RESS
      M1=M2=M3=M4=M5=M6=M7=M8=M9=M10=M11=M12=M13=0
      M1TTT=M2TTT=M3TTT=M4TTT=M5TTT=M6TTT=M7TTT=M8TTT=M9TTT=
     *M10TTT=M11TTT=M12TTT=M13TTT=M14TTT=M15TTT=0
      DO 300 I=1,12
      M1=MSCS1D(I)+M1
      M2=MSCS2D(I)+M2
      M3=MSCS3D(I)+M3
      M4=MSCS4D(I)+M4
      M5=MSCS1G(I)+M5
      M6=MSCS2G(I)+M6
      M7=MSCS3G(I)+M7
      M8=MSCS4G(I)+M8
      M9=MILL1(I)+M9
      M10=MILL2(I)+M10
      M11=MILL3(I)+M11
      M12=MILL4(I)+M12
      M13=MILL5(I)+M13
C
C*****************************************************
C
C THE CALCULATIONS BELOW ARE FOR DETERMINING THE PROB AND
C CUMMULATIVE PROBABILTIES FOR EACH AMC CLASS
C
C *****************************************************
C     DO CALCULATIONS FOR SCS DORMANT GROUP 1
      X=FLOAT(MONTHS(I)-MBAD(I))
      IF(X.EQ.0)THEN
      Q1(I)=Q2(I)=Q3(I)=Q4(I)=Q5(I)=Q6(I)=Q7(I)=Q8(I)=Q9(I)=Q10(I)=Q11
     *(I)=Q12(I)=Q13(I)=R1(I)=R2(I)=R3(I)=R4(I)=R5(I)=
     *R6(I)=R7(I)=R8(I)=R9(I)=R10(I)=R11(I)=R12(I)=R13(I)=0.0
      GOTO 300
      ELSE
      ENDIF
      Y=FLOAT(MSCS1D(I))
      Q1(I)=Y/X
      R1(I)=Q1(I)
C   DO CALCULATIONS FOR SCS DORMANT CLASS 2
      A=FLOAT(MSCS2D(I))
      Q2(I)=A/X
      R2(I)=R1(I)+Q2(I)
C    DO CALCULATIONS FOR SCS DORMANT CLASS 3
      B=FLOAT(MSCS3D(I))
      Q3(I)=B/X
      R3(I)=R2(I)+Q3(I)
C   DO CALCULATIONS FOR SCS DORMANT CLASS 4
      C=FLOAT(MSCS4D(I))
```

```
      Q4(I)=C/X
      R4(I)=R3(I)+Q4(I)
C    DO CALCULATIONS FOR SCS GROWING CLASS 1
      D=FLOAT(MSCS1G(I))
      Q5(I)=D/X
      R5(I)=Q5(I)
C   DO THE CALCULATIONS FOR SCS GROWING CLASS 2
      E=FLOAT(MSCS2G(I))
      Q6(I)=E/X
      R6(I)=R5(I)+Q6(I)
C   DO CALCULATIONS FOR SCS GROWING CLASS 3
      F=FLOAT(MSCS3G(I))
      Q7(I)=F/X
      R7(I)=Q7(I)+R6(I)
C   DO CALCULATIONS FOR SCS GROWING CLASS 4
      G=FLOAT(MSCS4G(I))
      Q8(I)=G/X
      R8(I)=Q8(I)+R7(I)
C   DO CALCULATIONS FOR ILLUDAS CLASS 1
      H=FLOAT(MILL1(I))
      Q9(I)=H/X
      R9(I)=Q9(I)
C   DO CALCULTIONS FOR ILLUDAS CLASS 2
      O=FLOAT(MILL2(I))
      Q10(I)=O/X
      R10(I)=Q10(I)+R9(I)
C   DO CALCULATIONS FOR ILLUDAS CLASS 3
      P=FLOAT(MILL3(I))
      Q11(I)=P/X
      R11(I)=Q11(I)+R10(I)
C   DO THE CALCULATIONS FOR ILLUDAS CLASS 4
      QQQ=FLOAT(MILL4(I))
      Q12(I)=QQQ/X
      R12(I)=Q12(I)+R11(I)
C   DO THE CALCULATIONS FOR ILLUDAS CLASS 5
      RRR=FLOAT(MILL5(I))
      Q13(I)=RRR/X
      R13(I)=Q13(I)+R12(I)
 300  CONTINUE
C    GET THE SUMS FOR SCS DORMANT CLASS 1
      NDAYS=151+NLEAP-MBADD
      Z=FLOAT(NDAYS)
      YY=FLOAT(M1)
      QS1=YY/Z
      RS1=QS1
C   GET THE SUMS FOR SCS DORMANT CLASS 2
      AA=FLOAT(M2)
      QS2=AA/Z
      RS2=RS1+QS2
C   GET THE SUMS FOR SCS DORMANT CLASS 3
      BB=FLOAT(M3)
      QS3=BB/Z
      RS3=RS2+QS3
C   GET THE SUMS FOR SCS DORMANT CLASS 4
      CC=FLOAT(M4)
      QS4=CC/Z
      RS4=RS3+QS4
C   GET THE TOTALS FOR SCS GROWING CLASS 1
      NDAYS=214-MBADG
      Z=FLOAT(NDAYS)
      DD=FLOAT(M5)
      QS5=DD/Z
      RS5=QS5
C   GET THE TOTALS FOR SCS GROWING CLASS 2
      NDAYS=214-MBADG
      Z=FLOAT(NDAYS)
      EE=FLOAT(M6)
      QS6=EE/Z
      RS6=RS5+QS6
C   GET THE TOTALS FOR SCS GROWING CLASS 3
      FF=FLOAT(M7)
      QS7=FF/Z
      RS7=QS7+RS6
C   GET THE TOATLS FOR SCS GROWING CLASS 4
      GG=FLOAT(M8)
      QS8=GG/Z
      RS8=RS7+QS8
C   GET THE TOTALS FOR ILLUDAS CLASS 1
      HH=FLOAT(M9)
      QS9=HH/Z
```

```
      RS9=QS9
C  GET THE TOTALS FOR ILLUDAS CLASS 2
      OO=FLOAT(M10)
      QS10=OO/Z
      RS10=RS9+QS10
C  GET THE TOTALS FOR ILLUDAS CLASS 3
      PP=FLOAT(M11)
      QS11=PP/Z
      RS11=RS10+QS11
C  GET THE TOTALS FOR ILLUDAS CLASS 4
      QQ=FLOAT(M12)
      QS12=QQ/Z
      RS12=RS11+QS12
C  GET THE TOTALS FOR ILLUDAS CLASS 5
      RR=FLOAT(M13)
      QS13=RR/Z
      RS13=RS12+QS13
C
C
C  AT THIS POINT WE CALCULATE THE CUMMULATIVE VALUES
C  FOR THE INCREMENTS AND CLASSES
C
C
C
      MBADDT=MBADDT+MBADD
      MBADGT=MBADGT+MBADG
      DO 650 I=1,12
      M1T(I)=MSCS1D(I)+M1T(I)
      M2T(I)=MSCS2D(I)+M2T(I)
      M3T(I)=MSCS3D(I)+M3T(I)
      M4T(I)=MSCS4D(I)+M4T(I)
      M5T(I)=MSCS1G(I)+M5T(I)
      M6T(I)=MSCS2G(I)+M6T(I)
      M7T(I)=MSCS3G(I)+M7T(I)
      M8T(I)=MSCS4G(I)+M8T(I)
      M9T(I)=MILL1(I)+M9T(I)
      M10T(I)=MILL2(I)+M10T(I)
      M11T(I)=MILL3(I)+M11T(I)
      M12T(I)=MILL4(I)+M12T(I)
      M13T(I)=MILL5(I)+M13T(I)
      M15T(I)=MBAD(I)+M15T(I)
 650  M14T(I)=L(I)+M14T(I)
C  CALCULATE THE NUMBER OF OCCURENCES FOR EACH INTERVAL
      DO 651 K=1,53
      DO 651 I=1,12
 651  MM(K,I)=MM(K,I)+N(K,I)
C
C*****************************************************
C AT THIS POINT WE HAVE ENTIRELY EVALUATED THE YEAR
C BEING INVESTIGATED AND PUT THE YEARS VALUES IN A
C RUNNING TOTAL.  IF THE YEAR FALLS INTO THE DECADE
C WE ARE IN, THE YEARLY TOTAL WILL BE PRINTED OUT. IF
C THE YEAR IS THE LAST ONE IN THE DECADE,THE YEARLY
C TOTALS WILL BE PRINTED OUT ALONG WITH THE DECADE TOTALS
C AND THE CUMMULATIVE VALUES TO DATE
C
C*****************************************************
C
C  M1T(I)= CUMMMULATIVE TOTALS FOR THE INCREMENTS FOR MONTH I
C*****************************************************
C CHECK TO SEE IF THE END OF THE DECADE HAS BEEN REACHED
C
C  IYEAR=FIRST YEAR OF THE DECADE
C  JYEAR=LAST YEAR OF THE DECADE
C
C*****************************************************
C
      IF(MYEAR.GE.IYEAR.AND.MYEAR.LE.JYEAR)GOTO 597
      IF(IYEAR.GT.MYEAR)GOTO 598
C
C*****************************************************
C  IF WE FALL WITHIN THE DECADE, WE NEED TO START TOTALING
C  THE NUMBER OF OCCURENCES IN EACH CATEGORY FOR THAT DECADE
C
C M1TT(I)=TEN YEAR CUMMULATIVE TOTAL FOR THE AMC CLASSES
C MMT(K,I)=THE TEN YEAR CUMMULATIVE TOTALS FOR THE INCREMENT
C          K FOR MONTH I
C
C*****************************************************
 597  CONTINUE
```

```
      MFLAG=0
      MBADDTT=MBADDTT+MBADD
      MBADGTT=MBADGTT+MBADG
      DO 620 I=1,12
      M1TT(I)=M1TT(I)+MSCS1D(I)
      M2TT(I)=M2TT(I)+MSCS2D(I)
      M3TT(I)=M3TT(I)+MSCS3D(I)
      M4TT(I)=M4TT(I)+MSCS4D(I)
      M5TT(I)=M5TT(I)+MSCS1G(I)
      M6TT(I)=M6TT(I)+MSCS2G(I)
      M7TT(I)=M7TT(I)+MSCS3G(I)
      M8TT(I)=M8TT(I)+MSCS4G(I)
      M9TT(I)=M9TT(I)+MILL1(I)
      M10TT(I)=M10TT(I)+MILL2(I)
      M11TT(I)=M11TT(I)+MILL3(I)
      M12TT(I)=M12TT(I)+MILL4(I)
      M13TT(I)=M13TT(I)+MILL5(I)
      M15TT(I)=M15TT(I)+MBAD(I)
 620  M14TT(I)=M14TT(I)+L(I)
      DO 625 K=1,53
      DO 625 I=1,12
 625  MMT(K,I)=MMT(K,I)+N(K,I)
C
C
C CHECK TO SEE IF THE YEAR IS THE LAST IN THE DECADE
C
C
      IF(MYEAR.EQ.JYEAR)THEN
      IYEAR=IYEAR+10
      JYEAR=JYEAR+10
      NFLAG=1
      GOTO 598
      ELSE
      NFLAG=0
      GOTO 598
      ENDIF
C
C
C NOW WE CAN CALCULATE THE TEN YEAR PROBABILITIES,
C CUM PROB, FOR THE AMC CLASSES  FOR EACH MONTH AND
C THE TOTALS FOR EACH CLASS.
C
C
      NFACT=10
 621  DO 622 I=1,12
      Y=FLOAT(MONTHS(I)-M15TT(I))
      IF(Y.EQ.0)THEN
      Q1(I)=Q2(I)=Q3(I)=Q4(I)=Q5(I)=Q6(I)=Q7(I)=Q8(I)=Q9(I)=Q10(I)=
     *Q11(I)=Q12(I)=Q13(I)=Q14(I)=Q15(I)=R1(I)=R2(I)=R3(I)=R4(I)=R5(I)=
     *R6(I)=R7(I)=R8(I)=R9(I)=R10(I)=R11(I)=R12(I)=R13(I)=R14(I)=R15(I)
     *=0.0
      GOTO 622
      ELSE
      ENDIF
      A=FLOAT(M1TT(I))
      Q1(I)=A/Y
      R1(I)=Q1(I)
      M1TTT=M1TTT+M1TT(I)
      B=FLOAT(M2TT(I))
      Q2(I)=B/Y
      R2(I)=Q2(I)+R1(I)
      M2TTT=M2TTT+M2TT(I)
      C=FLOAT(M3TT(I))
      Q3(I)=C/Y
      R3(I)=Q3(I)+R2(I)
      M3TTT=M3TTT+M3TT(I)
      D=FLOAT(M4TT(I))
      Q4(I)=D/Y
      R4(I)=Q4(I)+R3(I)
      M4TTT=M4TTT+M4TT(I)
      E=FLOAT(M5TT(I))
      Q5(I)=E/Y
      R5(I)=Q5(I)
      M5TTT=M5TTT+M5TT(I)
      F=FLOAT(M6TT(I))
      Q6(I)=F/Y
      R6(I)=R5(I)+Q6(I)
      M6TTT=M6TTT+M6TT(I)
      G=FLOAT(M7TT(I))
      Q7(I)=G/Y
```

```
      R7(I)=Q7(I)+R6(I)
      M7TTT=M7TTT+M7TT(I)
      H=FLOAT(M8TT(I))
      Q8(I)=H/Y
      R8(I)=Q8(I)+R7(I)
      M8TTT=M8TTT+M8TT(I)
      P=FLOAT(M9TT(I))
      Q9(I)=P/Y
      R9(I)=Q9(I)
      M9TTT=M9TTT+M9TT(I)
      QQ=FLOAT(M10TT(I))
      Q10(I)=QQ/Y
      R10(I)=R9(I)+Q10(I)
      M10TTT=M10TTT+M10TT(I)
      RR=FLOAT(M11TT(I))
      Q11(I)=RR/Y
      R11(I)=Q11(I)+R10(I)
      M11TTT=M11TTT+M11TT(I)
      SS=FLOAT(M12TT(I))
      Q12(I)=SS/Y
      R12(I)=Q12(I)+R11(I)
      M12TTT=M12TTT+M12TT(I)
      T=FLOAT(M13TT(I))
      Q13(I)=T/Y
      R13(I)=Q13(I)+R12(I)
      M13TTT=M13TTT+M13TT(I)
      Z=FLOAT(MONTHS(I))
      V=FLOAT(M15TT(I))
      Q15(I)=V/Z
      R15(I)=Q15(I)
      M15TTT=M15TTT+M15TT(I)
      U=FLOAT(M14TT(I))
      Q14(I)=U/Z
      R14(I)=Q14(I)+R15(I)
622   M14TTT=M14TTT+M14TT(I)
      NDAYS=(365+NLEAP)*NFACT
      W=FLOAT(M14TTT)
      A=FLOAT(M15TTT)
      V=FLOAT(NDAYS)
      QMS=A/V
      RMS=QMS
      QLS=W/V
      RLS=QLS+RMS
      NSS=0
C  NOW CALCULATE THE PROB AND CUM PROB FOR THE INCREMENT DATA
C
C
      NDAYS=(365+NLEAP)*NFACT
      DO 624 K=1,53
      DO 623 I=1,12
      X=FLOAT(MONTHS(I))
      Y=FLOAT(MMT(K,I))
      Q(K,I)=Y/X
      IF(K.EQ.1)THEN
      RES=R14(I)
      R(1,I)=Q(1,I)+RES
      ELSE
      RES=0.0
      R(K,I)=Q(K,I)+R(K-1,I)
      ENDIF
623   NSS=MMT(K,I)+NSS
      NS(K)=NSS
      Z=FLOAT(NS(K))
      NSS=0
      V=FLOAT(NDAYS)
      QS(K)=Z/V
      IF(K.EQ.1)THEN
      RESS=RLS
      ELSE
      RESS=0.0
      ENDIF
624   RS(K)=QS(K)+RS(K-1)+RESS
      NDAYS=(151+NLEAP)*NFACT-MBADDTT
C
C
C NOW CALCULATE THE PROB AMC CUM PROB FOR THE AMC CLASSES
C
      Z=FLOAT(NDAYS)
      A=FLOAT(M1TTT)
      QS1=A/Z
```

```
      RS1=QS1
      B=FLOAT(M2TTT)
      QS2=B/Z
      RS2=QS2+RS1
      C=FLOAT(M3TTT)
      QS3=C/Z
      RS3=QS3+RS2
      D=FLOAT(M4TTT)
      QS4=D/Z
      RS4=QS4+RS3
      NDAYS=214*NFACT-MBADGTT
      Z=FLOAT(NDAYS)
      E=FLOAT(M5TTT)
      QS5=E/Z
      RS5=QS5
      F=FLOAT(M6TTT)
      QS6=F/Z
      RS6=RS5+QS6
      G=FLOAT(M7TTT)
      QS7=G/Z
      RS7=QS7+RS6
      H=FLOAT(M8TTT)
      QS8=H/Z
      RS8=QS8+RS7
      P=FLOAT(M9TTT)
      QS9=P/Z
      RS9=QS9
      QQ=FLOAT(M10TTT)
      QS10=QQ/Z
      RS10=QS10+RS9
      RR=FLOAT(M11TTT)
      QS11=RR/Z
      RS11=QS11+RS10
      SS=FLOAT(M12TTT)
      QS12=SS/Z
      RS12=QS12+RS11
      T=FLOAT(M13TTT)
      QS13=T/Z
      RS13=QS13+RS12
      NFLAG=0
      GOTO 184
C
C
C  PRINT OUT THE INTERVAL DATA
C
C
 598  WRITE(6,199)(MBAD(I),I=1,12),MMS,QMS,RMS,(QM(I),RM(I),I=1,12)
      WRITE(6,599)(L(I),I=1,12),MLS,QLS,RLS,(QL(I),RL(I),I=1,12)
 599   FORMAT(2X,≠P00≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,1
     *2(≠*≠,F4.2,F4.2))
      DO 600 K=1,53
 600  WRITE(6,169)K,(N(K,I),I=1,12),NS(K),QS(K),RS(K),(Q(K,I),R(K,I),I=1
     *,12)
 169  FORMAT(2X,≠P≠,I2,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,1
     *2(≠*≠F4.2,F4.2))
C  PRINT OUT THE SCS DORMANT SEASON DATA
C
C
      WRITE(6,170)(MSCS1D(I),I=1,12),M1,QS1,RS1,(Q1(I),R1(I),I=1,12)
      WRITE(6,171)(MSCS2D(I),I=1,12),M2,QS2,RS2,(Q2(I),R2(I),I=1,12)
      WRITE(6,172)(MSCS3D(I),I=1,12),M3,QS3,RS3,(Q3(I),R3(I),I=1,12)
      WRITE(6,173)(MSCS4D(I),I=1,12),M4,QS4,RS4,(Q4(I),R4(I),I=1,12)
C  PRINT OUT THE SCS GROWING SEASONS
      WRITE(6,174)(MSCS1G(I),I=1,12),M5,QS5,RS5,(Q5(I),R5(I),I=1,12)
      WRITE(6,175)(MSCS2G(I),I=1,12),M6,QS6,RS6,(Q6(I),R6(I),I=1,12)
      WRITE(6,176)(MSCS3G(I),I=1,12),M7,QS7,RS7,(Q7(I),R7(I),I=1,12)
      WRITE(6,177)(MSCS4G(I),I=1,12),M8,QS8,RS8,(Q8(I),R8(I),I=1,12)
C  NOW PRINT OUT THE ILLUDAS CLASSES
      WRITE(6,178)(MILL1(I),I=1,12),M9,QS9,RS9,(Q9(I),R9(I),I=1,12)
      WRITE(6,179)(MILL2(I),I=1,12),M10,QS10,RS10,(Q10(I),R10(I),I=1,12)
      WRITE(6,180)(MILL3(I),I=1,12),M11,QS11,RS11,(Q11(I),R11(I),I=1,12)
      WRITE(6,181)(MILL4(I),I=1,12),M12,QS12,RS12,(Q12(I),R12(I),I=1,12)
      WRITE(6,182)(MILL5(I),I=1,12),M13,QS13,RS13,(Q13(I),R13(I),I=1,12)
 199  FORMAT(2X,≠BAD≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
 170  FORMAT(2X,≠S1D≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
 171  FORMAT(2X,≠S2D≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
 172  FORMAT(2X,≠S3D≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
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```
     *(≠*≠,F4.2,F4.2))
173  FORMAT(2X,≠S4D≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
174  FORMAT(2X,≠S1G≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
175  FORMAT(2X,≠S2G≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
176  FORMAT(2X,≠S3G≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
177  FORMAT(2X,≠S4G≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
178  FORMAT(2X,≠IL1≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
179  FORMAT(2X,≠IL2≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
180  FORMAT(2X,≠IL3≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
181  FORMAT(2X,≠IL4≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
182  FORMAT(2X,≠IL5≠,12(≠*≠,1X,I6,1X),2X,I5,1X,F4.2,1X,F4.2,/,≠ ≠,4X,12
     *(≠*≠,F4.2,F4.2))
      IF(NFLAG.EQ.1)THEN
      WRITE(6,183)IYEAR-10,JYEAR-10
      NFACT=10
      DO 187 I=1,12
187   MONTHS(I)=MONTHS(I)*10
      GOTO 621
      ELSE
      DO 969 I=1,12
      DO 969 J=1,31
      MINT(I,J)=MAXT(I,J)=200
969   PRCP(I,J)=SNOWD(I,J)=200.0
      GOTO 9
      ENDIF
184   WRITE(6,199)(M15TT(I),I=1,12),M15TTT,QMS,RMS,(Q15(I),R15(I),I=1,12
     *)
      WRITE(6,599)(M14TT(I),I=1,12),M14TTT,QLS,RLS,(Q14(I),R14(I),I=1,12
     *)
      DO 185 K=1,53
185   WRITE(6,169)K,(MMT(K,I),I=1,12),NS(K),QS(K),RS(K),(Q(K,I),R(K,I),
     *I=1,12)
      WRITE(6,170)(M1TT(I),I=1,12),M1TTT,QS1,RS1,(Q1(I),R1(I),I=1,12)
      WRITE(6,171)(M2TT(I),I=1,12),M2TTT,QS2,RS2,(Q2(I),R2(I),I=1,12)
      WRITE(6,172)(M3TT(I),I=1,12),M3TTT,QS3,RS3,(Q3(I),R3(I),I=1,12)
      WRITE(6,173)(M4TT(I),I=1,12),M4TTT,QS4,RS4,(Q4(I),R4(I),I=1,12)
      WRITE(6,174)(M5TT(I),I=1,12),M5TTT,QS5,RS5,(Q5(I),R5(I),I=1,12)
      WRITE(6,175)(M6TT(I),I=1,12),M6TTT,QS6,RS6,(Q6(I),R6(I),I=1,12)
      WRITE(6,176)(M7TT(I),I=1,12),M7TTT,QS7,RS7,(Q7(I),R7(I),I=1,12)
      WRITE(6,177)(M8TT(I),I=1,12),M8TTT,QS8,RS8,(Q8(I),R8(I),I=1,12)
      WRITE(6,178)(M9TT(I),I=1,12),M9TTT,QS9,RS9,(Q9(I),R9(I),I=1,12)
      WRITE(6,179)(M10TT(I),I=1,12),M10TTT,QS10,RS10,(Q10(I),R10(I),I=1,
     :12)
      WRITE(6,180)(M11TT(I),I=1,12),M11TTT,QS11,RS11,(Q11(I),R11(I),I=1,
     *12)
      WRITE(6,181)(M12TT(I),I=1,12),M12TTT,QS12,RS12,(Q12(I),R12(I),I=1,
     *12)
      WRITE(6,182)(M13TT(I),I=1,12),M13TTT,QS13,RS13,(Q13(I),R13(I),I=1,
     *12)
183   FORMAT(2X,≠************ TEN YEAR SUMMARY  ≠,I4,5X,≠THROUGH≠,2X,
     *I4,2X,≠*************≠)
      IF(NNFLAG.EQ.1)GOTO 9
      WRITE(6,186)NYEARE,JYEAR-10
186   FORMAT(2X,≠************* CUMULATIVE TOTALS ≠,2X,I4,2X,
     *≠THROUGH≠,2X,I4,2X,≠**************≠)
      DO 191 K=1,53
      DO 191 I=1,12
      M1TT(I)=M1T(I)
      M2TT(I)=M2T(I)
      M3TT(I)=M3T(I)
      M4TT(I)=M4T(I)
      M5TT(I)=M5T(I)
      M6TT(I)=M6T(I)
      M7TT(I)=M7T(I)
      M8TT(I)=M8T(I)
      M9TT(I)=M9T(I)
      M10TT(I)=M10T(I)
      M11TT(I)=M11T(I)
      M12TT(I)=M12T(I)
      M13TT(I)=M13T(I)
      M14TT(I)=M14T(I)
```

```
      M15TT(I)=M15T(I)
      RS(K)=0.0
      MBADDTT=MBADDT
      MBADGTT=MBADGT
191   MMT(K,I)=MM(K,I)
      M1TTT=M2TTT=M3TTT=M4TTT=M5TTT=M6TTT=M7TTT=M8TTT=M9TTT=
     *M10TTT=M11TTT=M12TTT=M13TTT=M14TTT=M15TTT=0
      MFLAG=1
      NNFLAG=1
      NFACT=(JYEAR-9-NYEARE)
      DO 188 I=1,12
188   MONTHS(I)=MONTHS(I)*(JYEAR-9-NYEARE)*.1
      GOTO 621
999    STOP
        END
```

# APPENDIX 2

## MONTHLY AMC PROBABILITIES

Table A2.1. Monthly SCS AMC Probabilities. Page 1 of 4.

| | | SCS AMC [%] | | | |
|---|---|---|---|---|---|
| Station | Month | I | II | III | IV |
| Berne | Jan.* | 13 | 5 | 12 | 71 |
| | Feb.* | 16 | 8 | 13 | 64 |
| | Mar.* | 32 | 16 | 20 | 32 |
| | April | 86 | 7 | 5 | 2 |
| | May | 92 | 6 | 3 | 0 |
| | June | 84 | 9 | 7 | 0 |
| | July | 86 | 9 | 5 | 0 |
| | Aug. | 89 | 8 | 3 | 0 |
| | Sept. | 87 | 8 | 4 | 0 |
| | Oct. | 91 | 6 | 2 | 0 |
| | Nov.* | 53 | 14 | 11 | 22 |
| | Dec.* | 20 | 8 | 11 | 62 |
| Mt. Vernon | Jan.* | 22 | 9 | 13 | 54 |
| | Feb.* | 28 | 13 | 21 | 39 |
| | Mar.* | 38 | 19 | 27 | 16 |
| | April | 86 | 6 | 8 | 0 |
| | May | 82 | 10 | 8 | 0 |
| | June | 87 | 8 | 6 | 0 |
| | July | 83 | 10 | 7 | 0 |
| | Aug. | 86 | 6 | 8 | 0 |
| | Sept. | 90 | 6 | 4 | 0 |
| | Oct. | 91 | 5 | 4 | 0 |
| | Nov.* | 54 | 17 | 18 | 11 |
| | Dec.* | 34 | 8 | 16 | 42 |

*Dormant Season

Table A2.1. Page 2 of 4.

| | | SCS AMC [%] | | | |
|---|---|---|---|---|---|
| Station | Month | I | II | III | IV |
| Paoli | Jan.* | 20 | 9 | 16 | 55 |
| | Feb.* | 24 | 12 | 22 | 43 |
| | Mar.* | 28 | 21 | 27 | 24 |
| | April | 83 | 9 | 7 | 1 |
| | May | 85 | 10 | 5 | 0 |
| | June | 80 | 10 | 10 | 0 |
| | July | 84 | 9 | 7 | 0 |
| | Aug. | 86 | 8 | 6 | 0 |
| | Sept. | 88 | 8 | 5 | 0 |
| | Oct. | 91 | 5 | 4 | 1 |
| | Nov.* | 45 | 19 | 18 | 18 |
| | Dec.* | 26 | 9 | 17 | 47 |
| Rockville | Jan.* | 16 | 6 | 13 | 64 |
| | Feb.* | 25 | 10 | 14 | 51 |
| | Mar.* | 38 | 19 | 19 | 24 |
| | April | 84 | 10 | 5 | 0 |
| | May | 86 | 7 | 7 | 0 |
| | June | 81 | 11 | 8 | 0 |
| | July | 84 | 8 | 9 | 0 |
| | Aug. | 88 | 7 | 5 | 0 |
| | Sept. | 89 | 7 | 4 | 0 |
| | Oct. | 91 | 5 | 4 | 0 |
| | Nov.* | 57 | 12 | 14 | 17 |
| | Dec.* | 24 | 10 | 12 | 53 |
| Rushville | Jan.* | 14 | 6 | 11 | 69 |
| | Feb.* | 19 | 8 | 13 | 61 |
| | Mar.* | 35 | 13 | 20 | 32 |
| | April | 84 | 8 | 5 | 3 |
| | May | 85 | 8 | 7 | 0 |
| | June | 86 | 6 | 9 | 0 |
| | July | 83 | 9 | 8 | 0 |
| | Aug. | 88 | 9 | 3 | 0 |
| | Sept. | 90 | 6 | 4 | 0 |
| | Oct. | 91 | 6 | 2 | 1 |
| | Nov.* | 51 | 14 | 14 | 21 |
| | Dec.* | 22 | 7 | 12 | 57 |

*Dormant Season

Table A2.1. Page 3 of 4.

| Station | Month | SCS AMC [%] I | II | III | IV |
|---|---|---|---|---|---|
| Spencer | Jan.* | 17 | 5 | 13 | 64 |
| | Feb.* | 21 | 11 | 16 | 53 |
| | Mar.* | 37 | 16 | 32 | 24 |
| | April | 84 | 10 | 4 | 1 |
| | May | 85 | 9 | 6 | 0 |
| | June | 80 | 9 | 11 | 0 |
| | July | 83 | 12 | 5 | 0 |
| | Aug. | 86 | 4 | 5 | 0 |
| | Sept. | 88 | 6 | 6 | 0 |
| | Oct. | 91 | 5 | 3 | 1 |
| | Nov.* | 48 | 18 | 16 | 19 |
| | Dec.* | 22 | 8 | 13 | 56 |
| Valparaiso | Jan.* | 7 | 3 | 9 | 81 |
| | Feb.* | 9 | 4 | 11 | 77 |
| | Mar.* | 31 | 13 | 18 | 38 |
| | April | 80 | 11 | 6 | 3 |
| | May | 86 | 8 | 6 | 0 |
| | June | 83 | 10 | 7 | 0 |
| | July | 88 | 7 | 5 | 0 |
| | Aug. | 86 | 8 | 6 | 0 |
| | Sept. | 87 | 6 | 7 | 0 |
| | Oct. | 88 | 7 | 5 | 0 |
| | Nov.* | 51 | 16 | 10 | 22 |
| | Dec.* | 15 | 6 | 9 | 70 |
| Vevay | Jan.* | 23 | 9 | 10 | 57 |
| | Feb.* | 30 | 13 | 16 | 42 |
| | Mar.* | 40 | 23 | 25 | 12 |
| | April | 81 | 13 | 5 | 0 |
| | May | 85 | 9 | 5 | 0 |
| | June | 83 | 9 | 8 | 0 |
| | July | 87 | 5 | 8 | 0 |
| | Aug. | 87 | 8 | 5 | 0 |
| | Sept. | 89 | 5 | 5 | 0 |
| | Oct. | 89 | 9 | 2 | 0 |
| | Nov.* | 56 | 18 | 16 | 10 |
| | Dec.* | 33 | 13 | 14 | 40 |

*Dormant Season

Table A2.1. Page 4 of 4.

| | | SCS AMC [%] | | | |
|---|---|---|---|---|---|
| Station | Month | I | II | III | IV |
| Waterloo | Jan.* | 7 | 5 | 9 | 79 |
| | Feb.* | 10 | 7 | 11 | 73 |
| | Mar.* | 32 | 17 | 14 | 38 |
| | April | 88 | 6 | 2 | 4 |
| | May | 90 | 7 | 3 | 0 |
| | June | 89 | 8 | 3 | 0 |
| | July | 87 | 8 | 5 | 0 |
| | Aug. | 90 | 6 | 4 | 0 |
| | Sept. | 90 | 4 | 6 | 0 |
| | Oct. | 90 | 5 | 4 | 1 |
| | Nov.* | 51 | 14 | 11 | 24 |
| | Dec.* | 14 | 5 | 10 | 71 |
| W. Lafayette | Jan.* | 9 | 4 | 8 | 78 |
| | Feb.* | 19 | 7 | 8 | 68 |
| | Mar.* | 36 | 16 | 13 | 35 |
| | April | 83 | 9 | 5 | 3 |
| | May | 88 | 5 | 6 | 0 |
| | June | 84 | 8 | 8 | 0 |
| | July | 83 | 9 | 8 | 0 |
| | Aug. | 88 | 5 | 7 | 0 |
| | Sept. | 87 | 7 | 6 | 0 |
| | Oct. | 91 | 5 | 4 | 0 |
| | Nov.* | 51 | 13 | 11 | 25 |
| | Dec.* | 21 | 6 | 8 | 66 |

*Dormant Season

Table A2.2. Monthly ILLUDAS AMC Probabilities. Page 1 of 2.

| Station | Month | ILLUDAS AMC [%] 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Berne | April | 11 | 41 | 21 | 24 | 2 |
| | May | 17 | 39 | 24 | 21 | 0 |
| | June | 19 | 32 | 22 | 27 | 0 |
| | July | 17 | 41 | 19 | 23 | 0 |
| | Aug. | 14 | 39 | 17 | 20 | 0 |
| | Sept. | 22 | 40 | 19 | 20 | 0 |
| | Oct. | 28 | 42 | 19 | 11 | 0 |
| Mt. Vernon | April | 15 | 41 | 18 | 26 | 0 |
| | May | 23 | 31 | 17 | 29 | 0 |
| | June | 24 | 30 | 18 | 28 | 0 |
| | July | 23 | 36 | 16 | 25 | 0 |
| | Aug. | 33 | 32 | 15 | 20 | 0 |
| | Sept. | 34 | 37 | 13 | 15 | 0 |
| | Oct. | 37 | 33 | 15 | 15 | 0 |
| Paoli | April | 12 | 41 | 19 | 26 | 1 |
| | May | 21 | 36 | 19 | 25 | 0 |
| | June | 21 | 28 | 20 | 30 | 0 |
| | July | 19 | 36 | 20 | 25 | 0 |
| | Aug. | 31 | 30 | 15 | 24 | 0 |
| | Sept. | 31 | 34 | 15 | 20 | 0 |
| | Oct. | 30 | 36 | 17 | 17 | 0 |
| Rockville | April | 15 | 39 | 17 | 28 | 0 |
| | May | 21 | 35 | 21 | 24 | 0 |
| | June | 23 | 32 | 28 | 27 | 0 |
| | July | 24 | 31 | 19 | 25 | 0 |
| | Aug. | 31 | 34 | 15 | 20 | 0 |
| | Sept. | 30 | 34 | 17 | 19 | 0 |
| | Oct. | 38 | 33 | 15 | 14 | 0 |

Table A2.2. Page 2 of 2.

| | | ILLUDAS AMC [%] | | | | |
|---|---|---|---|---|---|---|
| Station | Month | 1 | 2 | 3 | 4 | 5 |
| Rushville | April | 16 | 38 | 21 | 22 | 3 |
| | May | 20 | 33 | 24 | 23 | 0 |
| | June | 23 | 32 | 21 | 25 | 0 |
| | July | 23 | 31 | 18 | 27 | 0 |
| | Aug. | 30 | 35 | 16 | 20 | 0 |
| | Sept. | 28 | 36 | 17 | 19 | 0 |
| | Oct. | 32 | 34 | 18 | 14 | 1 |
| Spencer | April | 14 | 35 | 21 | 23 | 1 |
| | May | 19 | 36 | 24 | 25 | 0 |
| | June | 18 | 31 | 21 | 29 | 0 |
| | July | 25 | 32 | 18 | 26 | 0 |
| | Aug. | 25 | 36 | 16 | 22 | 0 |
| | Sept. | 28 | 39 | 17 | 18 | 0 |
| | Oct. | 28 | 41 | 18 | 13 | 1 |
| Valparaiso | April | 9 | 40 | 20 | 27 | 3 |
| | May | 18 | 36 | 24 | 21 | 0 |
| | June | 19 | 34 | 20 | 26 | 0 |
| | July | 16 | 39 | 24 | 21 | 0 |
| | Aug. | 22 | 37 | 19 | 22 | 0 |
| | Sept. | 23 | 39 | 17 | 20 | 0 |
| | Oct. | 23 | 42 | 17 | 17 | 0 |
| Vevay | April | 12 | 35 | 25 | 28 | 0 |
| | May | 23 | 36 | 18 | 23 | 0 |
| | June | 24 | 36 | 15 | 25 | 0 |
| | July | 18 | 37 | 23 | 22 | 0 |
| | Aug. | 25 | 39 | 13 | 22 | 0 |
| | Sept. | 24 | 42 | 16 | 17 | 0 |
| | Oct. | 32 | 42 | 10 | 17 | 0 |
| Waterloo | April | 15 | 40 | 23 | 18 | 4 |
| | May | 23 | 37 | 22 | 19 | 0 |
| | June | 21 | 38 | 21 | 20 | 0 |
| | July | 23 | 39 | 18 | 20 | 0 |
| | Aug. | 31 | 34 | 18 | 17 | 0 |
| | Sept. | 30 | 37 | 17 | 16 | 0 |
| | Oct. | 33 | 38 | 14 | 14 | 1 |
| W. Lafayette | April | 12 | 40 | 20 | 24 | 3 |
| | May | 20 | 36 | 21 | 23 | 0 |
| | June | 22 | 30 | 19 | 29 | 0 |
| | July | 22 | 38 | 18 | 23 | 0 |
| | Aug. | 28 | 33 | 18 | 20 | 0 |
| | Sept. | 24 | 42 | 14 | 20 | 0 |
| | Oct. | 28 | 42 | 14 | 15 | 0 |

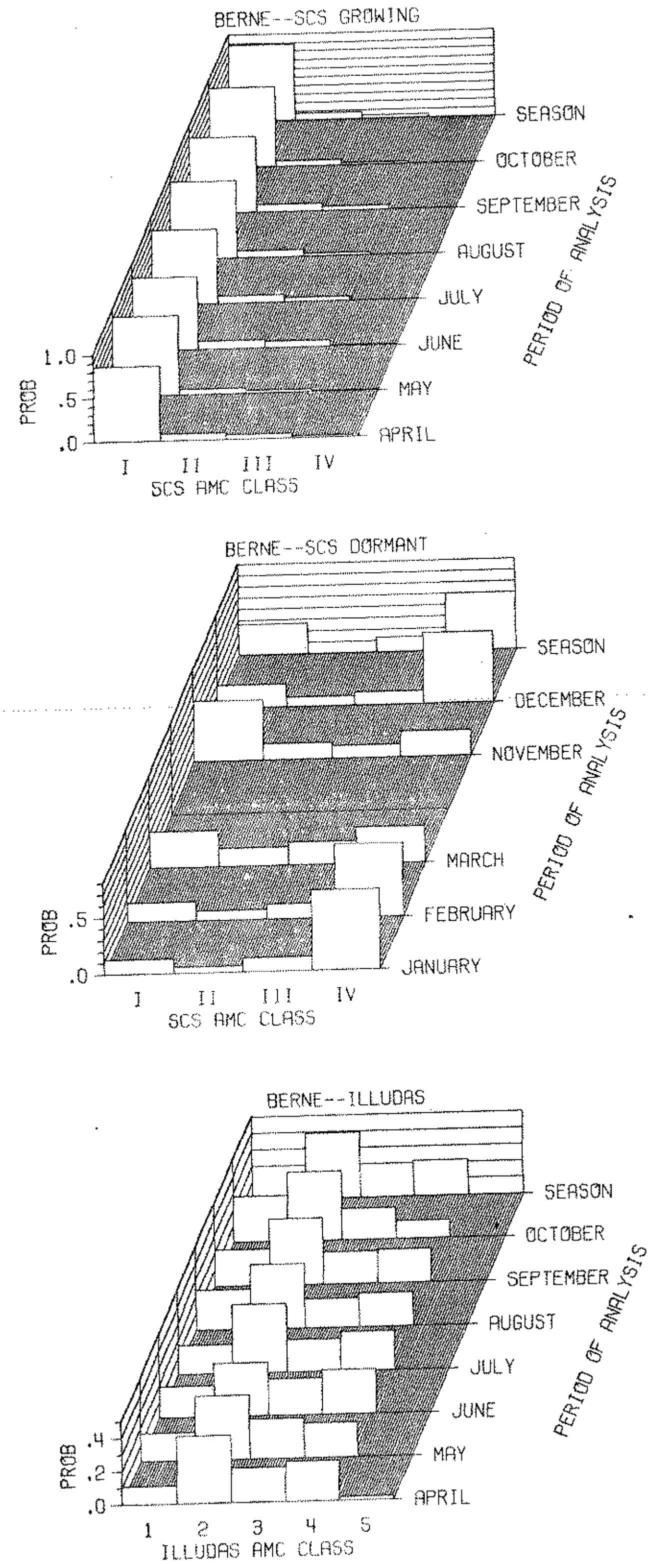


Figure A2.1. Monthly AMC Probabilities - Berne, Indiana (1948-77).

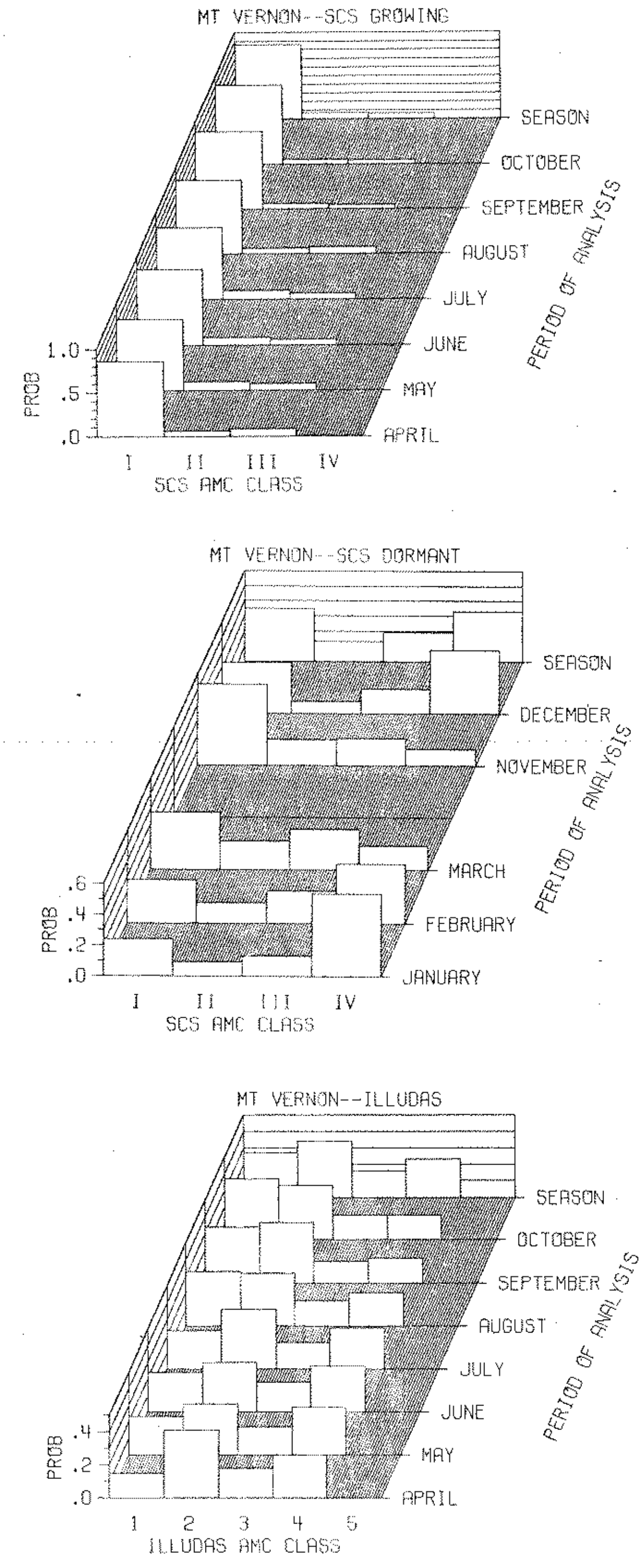


Figure A2. 2. Monthly AMC Probabilities - Mt. Vernon, Indiana (1948-77).

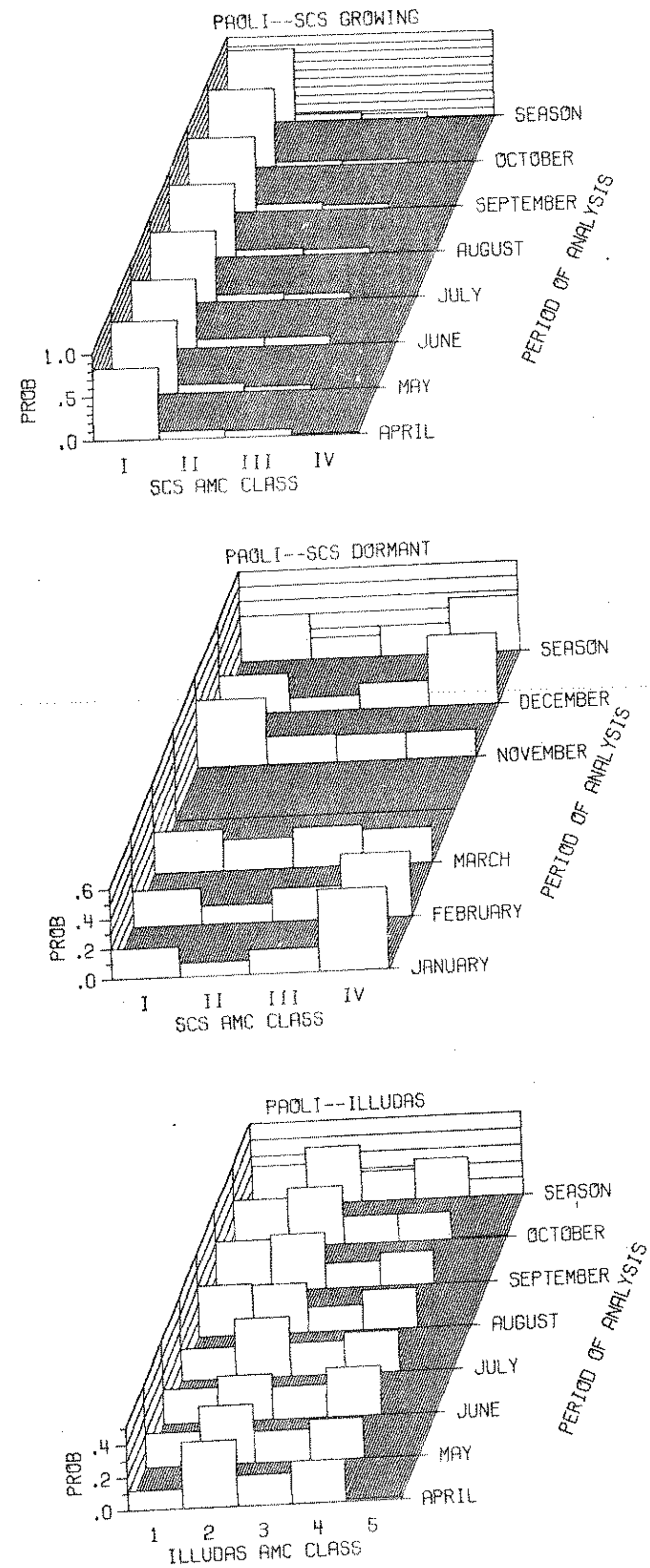


Figure A2.3. Monthly AMC Probabilities - Paoli, Indiana (1948-77).

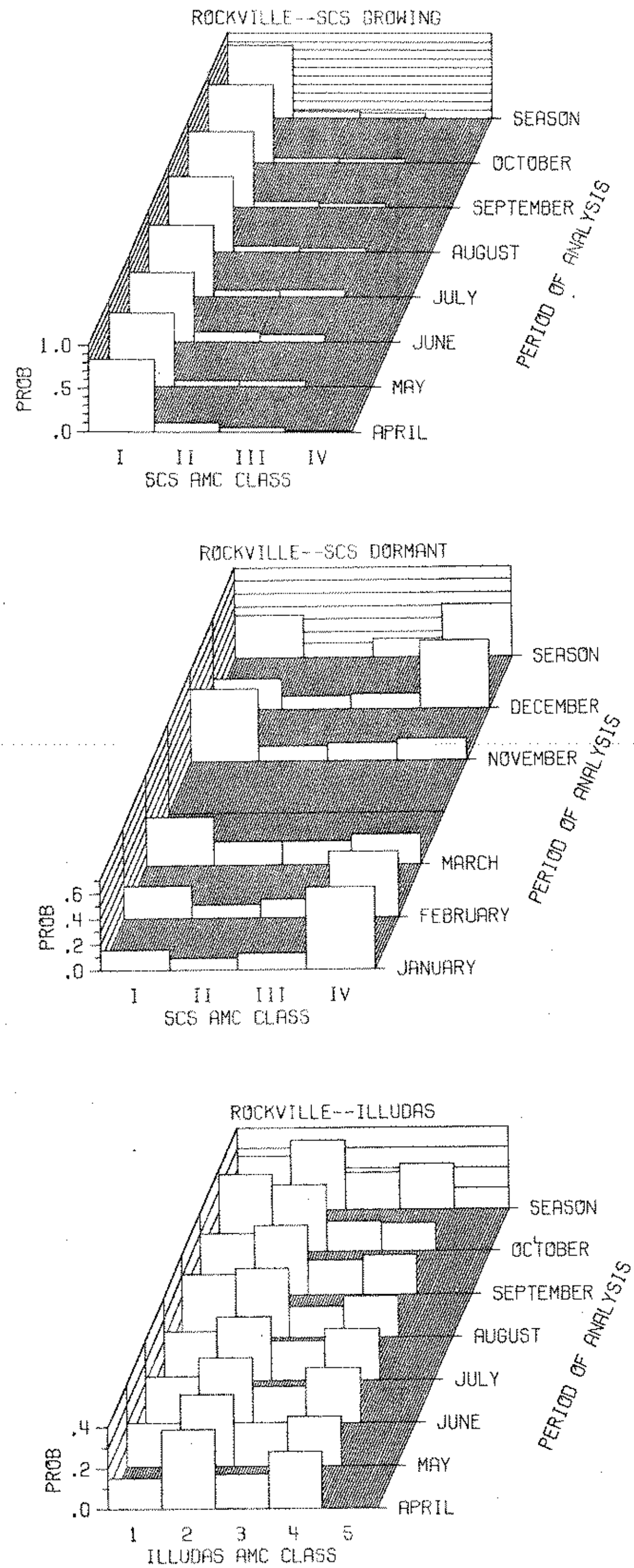


Figure A2.4. Monthly AMC Probabilities - Rockville, Indiana (1948-77).

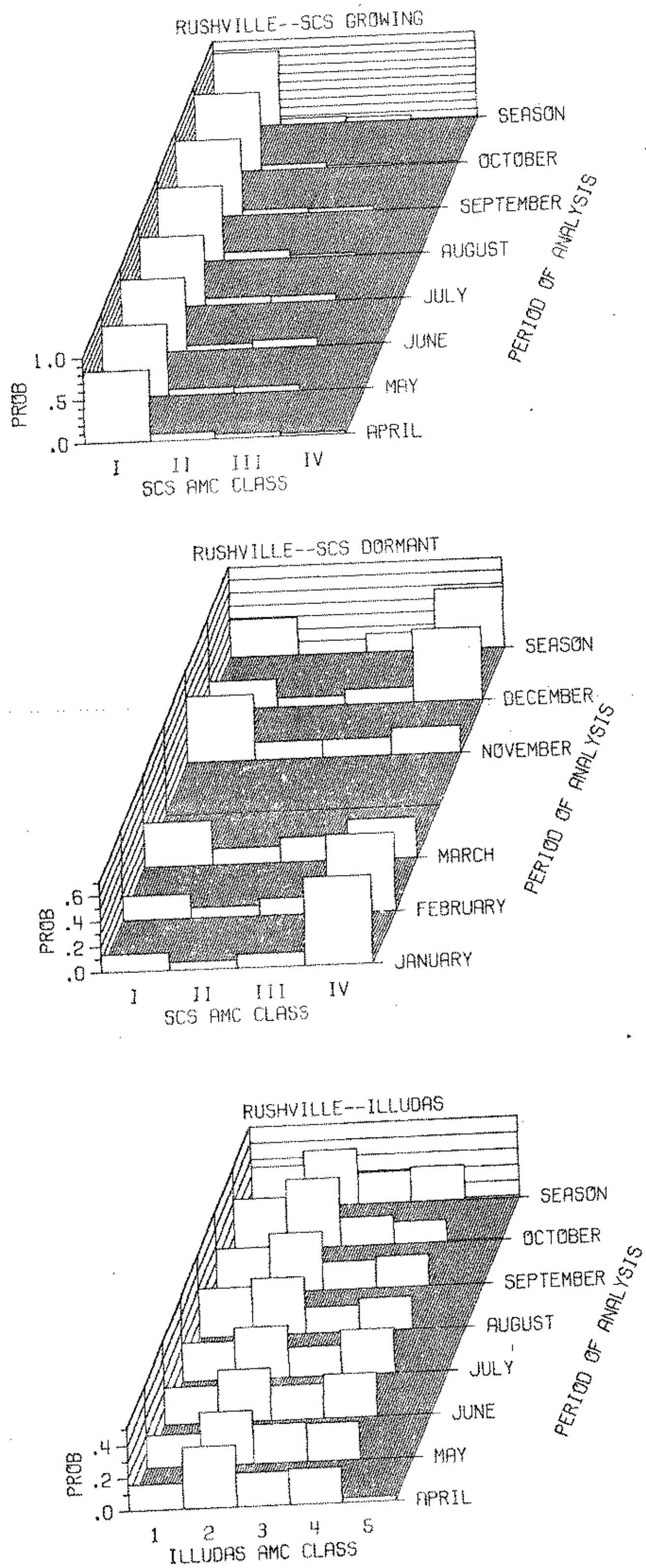


Figure A2.5. Monthly AMC Probabilities - Rushville, Indiana (1948-77).

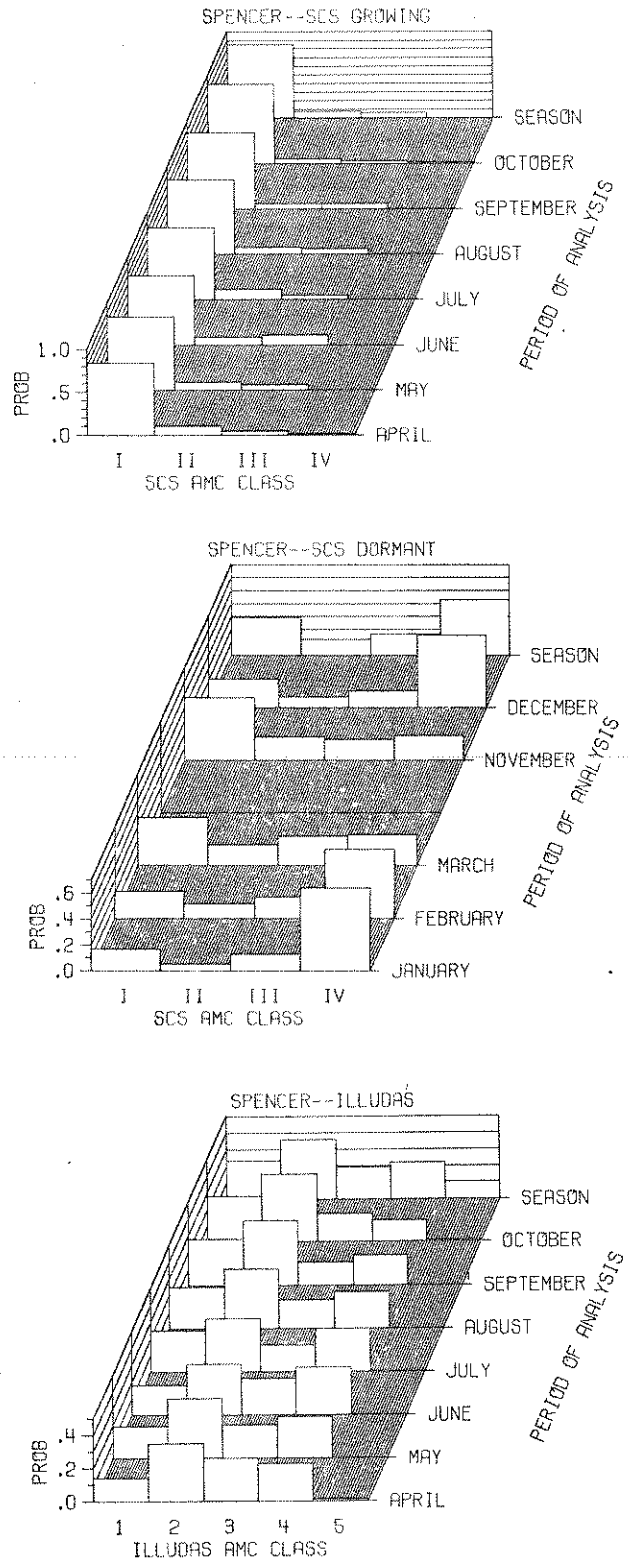


Figure A2.6. Monthly AMC Probabilities - Spencer, Indiana (1950-77).

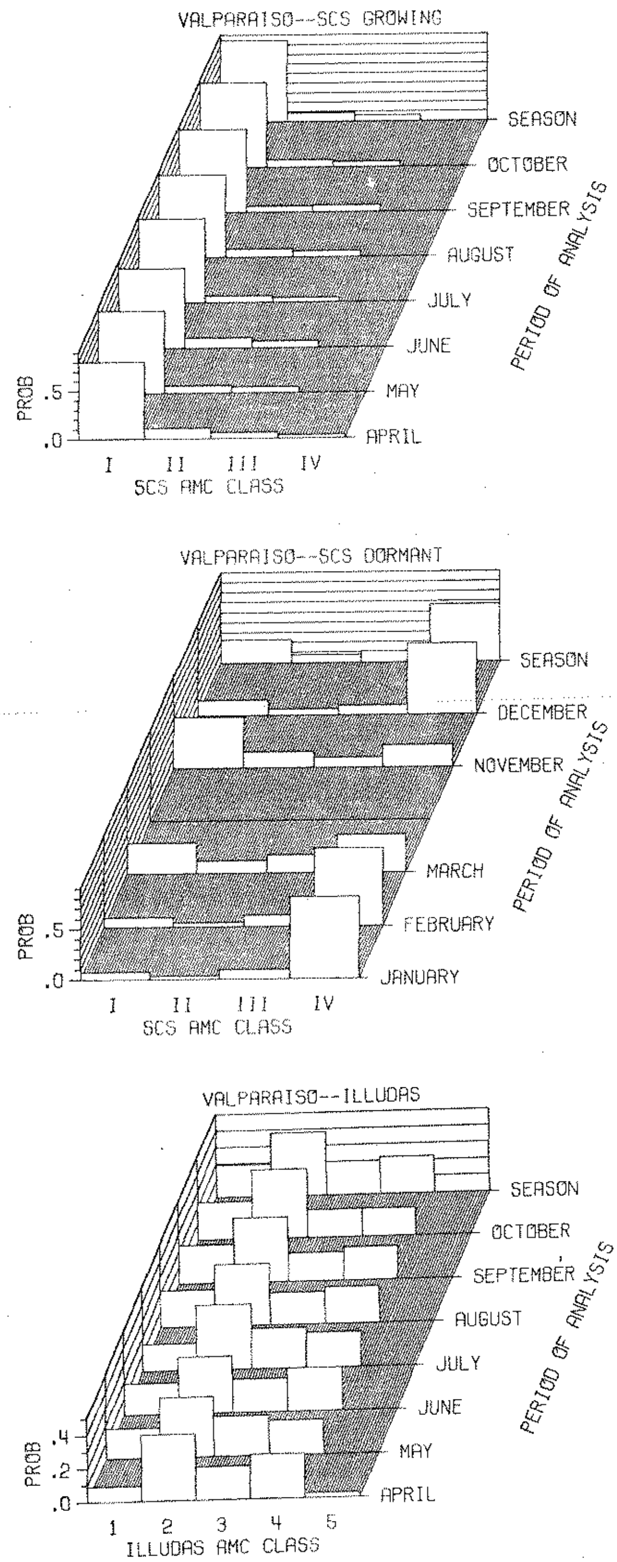


Figure A2.7. Monthly AMC Probabilities - Valparaiso, Indiana (1948-77).

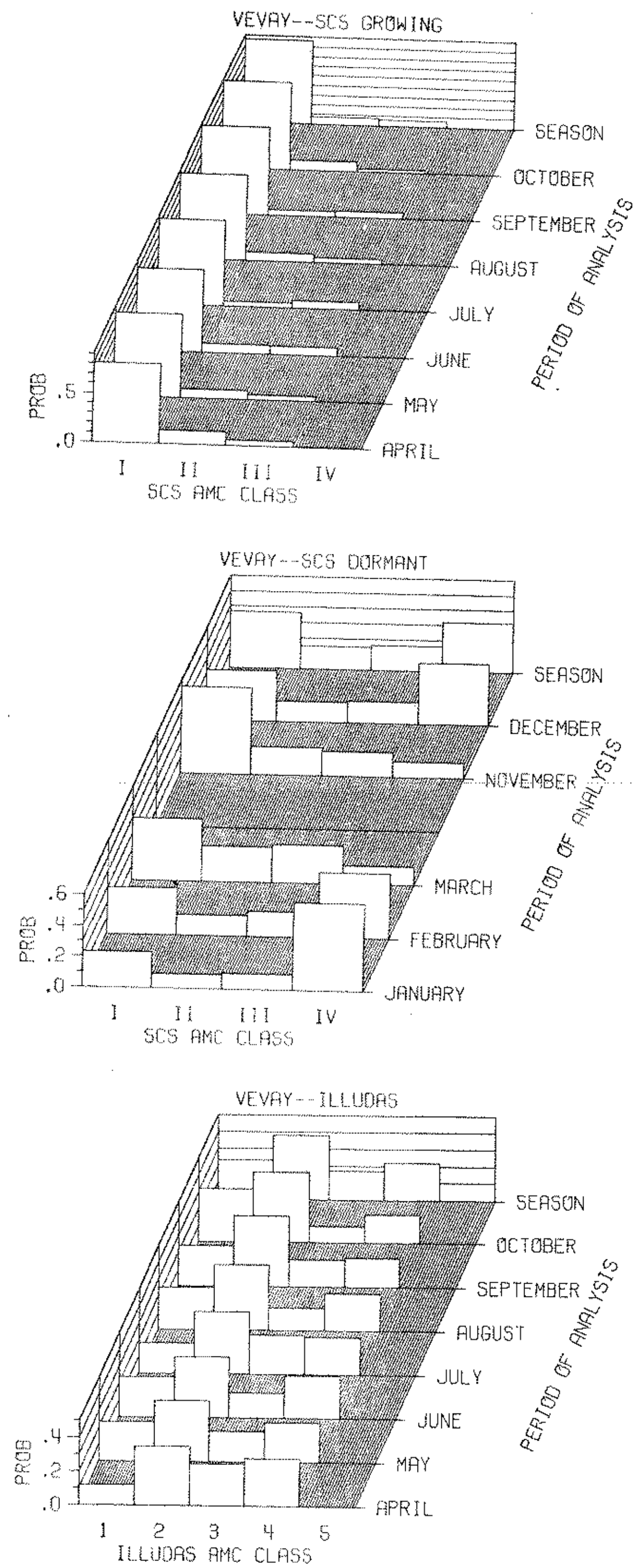


Figure A2.8. Monthly AMC Probabilities - Vevay, Indiana (1961-77).

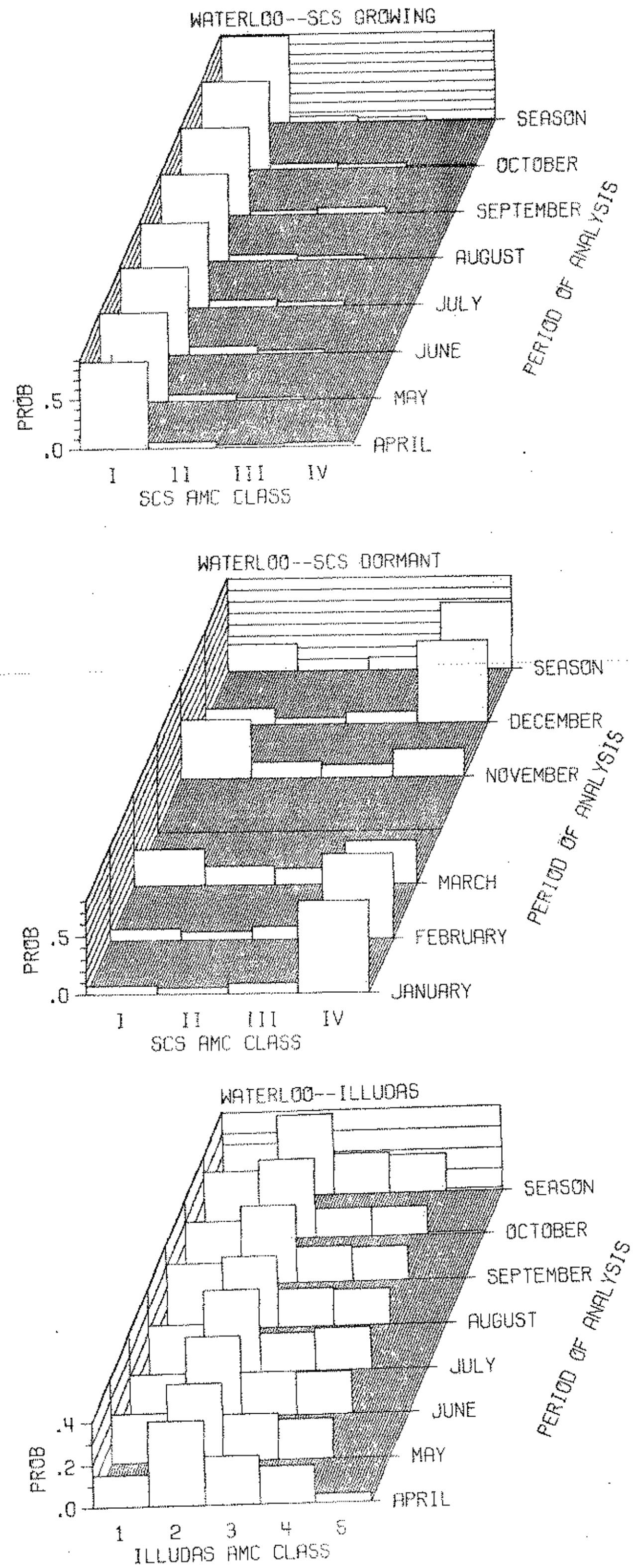


Figure A2.9. Monthly AMC Probabilities - Waterloo, Indiana (1948-77).

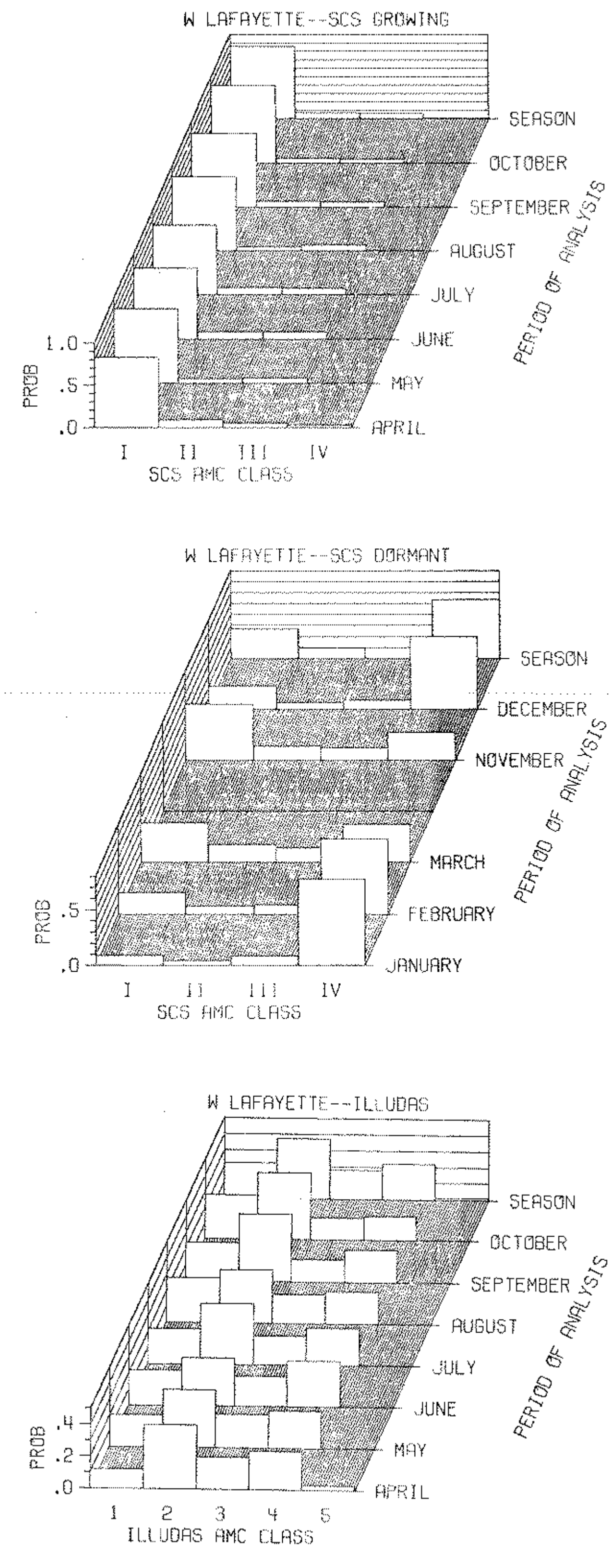


Figure A2.10. Monthly AMC Probabilities - West Lafayette, Indiana (1954-77).

# APPENDIX 3

## CUMULATIVE DISTRIBUTION TABLES

Table A3.1. Cumulative Distribution Function
Berne, Indiana (1948-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data | 5 | 5 | 9 | 6 | 1 | 1 | 3 | 3 | 2 | 1 | 2 | 2 | 3 |
| Frozen | 72 | 66 | 38 | 8 | 1 | 1 | 3 | 3 | 2 | 2 | 24 | 63 | 23 |
| Prob<(in.) 0.1 | 78 | 72 | 48 | 34 | 30 | 28 | 33 | 39 | 39 | 41 | 49 | 71 | 47 |
| 0.2 | 81 | 75 | 53 | 42 | 38 | 36 | 41 | 47 | 48 | 50 | 59 | 74 | 53 |
| 0.3 | 83 | 77 | 58 | 48 | 44 | 42 | 48 | 55 | 53 | 58 | 65 | 77 | 59 |
| 0.4 | 84 | 79 | 62 | 54 | 50 | 47 | 51 | 60 | 58 | 65 | 71 | 79 | 63 |
| 0.5 | 85 | 83 | 67 | 57 | 56 | 51 | 59 | 64 | 62 | 71 | 76 | 82 | 68 |
| 0.6 | 85 | 85 | 69 | 62 | 62 | 55 | 64 | 67 | 66 | 76 | 78 | 84 | 71 |
| 0.7 | 87 | 86 | 73 | 67 | 68 | 62 | 68 | 73 | 71 | 81 | 83 | 86 | 75 |
| 0.8 | 87 | 87 | 76 | 70 | 72 | 66 | 71 | 76 | 73 | 84 | 85 | 87 | 78 |
| 0.9 | 89 | 89 | 79 | 73 | 75 | 70 | 75 | 79 | 77 | 87 | 88 | 88 | 81 |
| 1.0 | 89 | 90 | 81 | 77 | 80 | 73 | 78 | 81 | 81 | 89 | 89 | 89 | 83 |
| 1.1 | 89 | 91 | 83 | 80 | 83 | 75 | 81 | 83 | 82 | 90 | 91 | 90 | 85 |
| 1.2 | 90 | 91 | 86 | 84 | 86 | 79 | 83 | 85 | 85 | 91 | 92 | 91 | 87 |
| 1.3 | 92 | 92 | 87 | 87 | 90 | 81 | 85 | 87 | 87 | 92 | 94 | 92 | 89 |
| 1.4 | 92 | 92 | 88 | 89 | 92 | 84 | 87 | 89 | 88 | 92 | 94 | 93 | 90 |
| 1.5 | 93 | 92 | 89 | 90 | 93 | 86 | 87 | 91 | 89 | 93 | 94 | 94 | 91 |
| 1.6 | 93 | 92 | 91 | 91 | 94 | 86 | 90 | 94 | 91 | 95 | 95 | 94 | 92 |
| 1.7 | 94 | 93 | 92 | 92 | 95 | 87 | 92 | 94 | 92 | 95 | 95 | 94 | 93 |
| 1.8 | 94 | 94 | 93 | 93 | 95 | 89 | 93 | 95 | 93 | 96 | 96 | 95 | 94 |
| 1.9 | 95 | 94 | 94 | 94 | 96 | 90 | 93 | 96 | 94 | 97 | 96 | 95 | 95 |
| 2.0 | 96 | 94 | 94 | 95 | 97 | 92 | 94 | 97 | 95 | 97 | 97 | 95 | 95 |
| 2.1 | 96 | 94 | 94 | 96 | 97 | 93 | 95 | 97 | 96 | 98 | 97 | 95 | 96 |
| 2.2 | 96 | 95 | 95 | 96 | 98 | 93 | 96 | 98 | 96 | 98 | 97 | 96 | 96 |
| 2.3 | 96 | 95 | 95 | 97 | 98 | 94 | 97 | 98 | 96 | 99 | 97 | 96 | 96 |
| 2.4 | 96 | 95 | 95 | 97 | 98 | 95 | 98 | 98 | 96 | 99 | 98 | 96 | 97 |
| 2.5 | 97 | 95 | 95 | 97 | 98 | 96 | 98 | 98 | 96 | 99 | 98 | 96 | 97 |
| 2.6 | 97 | 96 | 96 | 98 | 99 | 96 | 99 | 99 | 97 | 99 | 98 | 96 | 97 |

Table A3.1. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 97 | 96 | 96 | 98 | 99 | 97 | 99 | 99 | 97 | 99 | 98 | 97 | 98 |
| 2.8 | 97 | 96 | 97 | 98 | 99 | 98 | 99 | 99 | 97 | 99 | 98 | 97 | 98 |
| 2.9 | 97 | 97 | 97 | 98 | 100 | 98 | 99 | 99 | 98 | 99 | 98 | 97 | 98 |
| 3.0 | 98 | 97 | 97 | 98 | | 98 | 99 | 99 | 98 | 99 | 98 | 97 | 98 |
| 3.1 | 98 | 97 | 97 | 98 | | 98 | 99 | 99 | 99 | 99 | 98 | 98 | 98 |
| 3.2 | 98 | 97 | 97 | 98 | | 99 | 99 | 99 | 99 | 99 | 98 | 98 | 99 |
| 3.3 | 98 | 97 | 97 | 99 | | 99 | 99 | 100 | 99 | 99 | 99 | 98 | 99 |
| 3.4 | 98 | 98 | 97 | 99 | | 99 | 100 | | 99 | 99 | 99 | 98 | 99 |
| 3.5 | 98 | 98 | 97 | 99 | | 99 | | | 99 | 100 | 99 | 98 | 99 |
| 3.6 | 98 | 98 | 98 | 99 | | 99 | | | 99 | | 99 | 98 | 99 |
| 3.7 | 98 | 98 | 98 | 99 | | 99 | | | 99 | | 99 | 98 | 99 |
| 3.8 | 98 | 98 | 98 | 99 | | 99 | | | 99 | | 99 | 98 | 99 |
| 3.9 | 98 | 99 | 98 | 99 | | 99 | | | 99 | | 99 | 98 | 99 |
| 4.0 | 98 | 99 | 98 | 99 | | 99 | | | 99 | | 99 | 98 | 99 |
| 4.1 | 98 | 99 | 98 | 100 | | 99 | | | 99 | | 100 | 98 | 99 |
| 4.2 | 98 | 99 | 98 | | | 99 | | | 99 | | | 98 | 99 |
| 4.3 | 98 | 99 | 98 | | | 99 | | | 99 | | | 98 | 99 |
| 4.4 | 98 | 99 | 98 | | | 99 | | | 99 | | | 98 | 99 |
| 4.5 | 99 | 99 | 98 | | | 99 | | | 99 | | | 98 | 99 |
| 4.6 | 99 | 99 | 99 | | | 99 | | | 99 | | | 98 | 99 |
| 4.7 | 99 | 99 | 99 | | | 99 | | | 99 | | | 98 | 99 |
| 4.8 | 99 | 100 | 99 | | | 100 | | | 99 | | | 98 | 100 |
| 4.9 | 99 | | 99 | | | | | | 99 | | | 98 | |
| 5.0 | 99 | | 99 | | | | | | 100 | | | 99 | |
| 5.1 | 99 | | 99 | | | | | | | | | 99 | |
| 5.2 | 99 | | 99 | | | | | | | | | 99 | |
| 5.3 | 1.00 | | 1.00 | | | | | | | | | 100 | |

Table A3.2. Cumulative Distribution Function
Mt. Vernon, Indiana (1948-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data | 8 | 4 | 6 | 6 | 2 | 3 | 3 | 7 | 5 | 7 | 9 | 8 | 6 |
| Frozen | 58 | 41 | 22 | 6 | 2 | 3 | 3 | 7 | 5 | 7 | 20 | 47 | 18 |
| Prob<(in.) 0.1 | 70 | 55 | 39 | 29 | 33 | 36 | 36 | 47 | 49 | 53 | 51 | 65 | 47 |
| 0.2 | 73 | 59 | 46 | 38 | 39 | 42 | 44 | 54 | 56 | 59 | 57 | 69 | 53 |
| 0.3 | 75 | 63 | 49 | 47 | 45 | 46 | 53 | 57 | 63 | 65 | 61 | 72 | 58 |
| 0.4 | 77 | 67 | 53 | 53 | 51 | 49 | 57 | 64 | 66 | 69 | 65 | 75 | 62 |
| 0.5 | 80 | 68 | 57 | 59 | 55 | 56 | 60 | 67 | 73 | 72 | 69 | 78 | 66 |
| 0.6 | 82 | 70 | 62 | 62 | 59 | 60 | 64 | 73 | 75 | 76 | 72 | 79 | 69 |
| 0.7 | 84 | 73 | 65 | 66 | 62 | 63 | 68 | 75 | 78 | 79 | 75 | 80 | 73 |
| 0.8 | 86 | 75 | 69 | 70 | 66 | 68 | 72 | 78 | 81 | 82 | 78 | 82 | 76 |
| 0.9 | 86 | 77 | 73 | 73 | 70 | 71 | 74 | 80 | 83 | 84 | 80 | 83 | 78 |
| 1.0 | 88 | 81 | 75 | 75 | 72 | 73 | 76 | 82 | 85 | 86 | 84 | 86 | 80 |
| 1.1 | 89 | 82 | 78 | 78 | 75 | 77 | 77 | 82 | 87 | 88 | 86 | 87 | 82 |
| 1.2 | 90 | 83 | 79 | 81 | 79 | 82 | 80 | 84 | 88 | 89 | 88 | 88 | 84 |
| 1.3 | 90 | 85 | 80 | 83 | 80 | 85 | 82 | 85 | 89 | 90 | 89 | 90 | 86 |
| 1.4 | 91 | 86 | 82 | 87 | 82 | 87 | 84 | 87 | 90 | 91 | 91 | 91 | 88 |
| 1.5 | 92 | 87 | 84 | 89 | 84 | 88 | 87 | 88 | 91 | 92 | 92 | 93 | 89 |
| 1.6 | 92 | 88 | 84 | 90 | 86 | 89 | 88 | 89 | 92 | 93 | 93 | 93 | 90 |
| 1.7 | 93 | 89 | 86 | 91 | 87 | 90 | 90 | 90 | 93 | 94 | 93 | 94 | 91 |
| 1.8 | 93 | 90 | 87 | 91 | 88 | 91 | 90 | 91 | 95 | 95 | 94 | 95 | 92 |
| 1.9 | 93 | 92 | 88 | 92 | 90 | 92 | 91 | 91 | 95 | 95 | 95 | 95 | 92 |
| 2.0 | 94 | 92 | 89 | 92 | 92 | 94 | 93 | 92 | 96 | 96 | 96 | 95 | 93 |
| 2.1 | 94 | 93 | 89 | 93 | 92 | 95 | 93 | 93 | 96 | 96 | 96 | 96 | 94 |
| 2.2 | 94 | 93 | 90 | 93 | 93 | 95 | 94 | 93 | 97 | 97 | 97 | 96 | 94 |
| 2.3 | 94 | 94 | 92 | 94 | 93 | 95 | 95 | 94 | 97 | 97 | 97 | 96 | 95 |
| 2.4 | 94 | 94 | 92 | 94 | 94 | 96 | 96 | 95 | 97 | 97 | 98 | 97 | 95 |
| 2.5 | 95 | 95 | 92 | 95 | 95 | 97 | 96 | 95 | 97 | 98 | 98 | 97 | 96 |
| 2.6 | 95 | 95 | 93 | 95 | 95 | 98 | 97 | 96 | 97 | 98 | 98 | 97 | 96 |

Table A3.2. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 95 | 95 | 94 | 96 | 96 | 98 | 97 | 96 | 97 | 98 | 98 | 97 | 97 |
| 2.8 | 96 | 95 | 95 | 96 | 97 | 98 | 97 | 96 | 97 | 98 | | 98 | 97 |
| 2.9 | 96 | 96 | 95 | 96 | | 99 | 98 | 97 | 98 | 98 | | | 97 |
| 3.0 | 96 | 97 | 95 | 97 | | | | 97 | 99 | 98 | | | 97 |
| 3.1 | 97 | | 96 | 97 | | | | 98 | | 99 | | | 98 |
| 3.2 | 97 | | 97 | 97 | | | | | | | | | 98 |
| 3.3 | 97 | | 97 | 98 | | | 99 | | | | | 99 | 98 |
| 3.4 | 97 | 97 | 98 | | 98 | | | | | | 99 | | 98 |
| 3.5 | 97 | 98 | | | | 100 | | | 100 | 100 | | | 98 |
| 3.6 | 98 | | | | | | | | | | | | 99 |
| 3.7 | | | | | | | | 99 | | | | | |
| 3.8 | | | | 99 | | | | | | | | | |
| 3.9 | | | | | | | | | | | | | |
| 4.0 | | | 99 | | | | | 100 | | | | | |
| 4.1 | | 99 | | | | | | | | | | | |
| 4.2 | | | | 100 | | | | | | | | | |
| 4.3 | | | | | | | 100 | | | | | 100 | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | | | | | | | | | | | | | |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | 100 | | | | | | | | | 100 | | 100 |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | | |
| 5.1 | | | | | | | | | | | | | |
| 5.2 | 98 | | | | | | | | | | | | |
| 5.3 | 100 | | 100 | | 100 | | | | | | | | |

Table A3.3. Cumulative Distribution Function
Paoli, Indiana (1948-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data | 34 | 31 | 38 | 5 | 6 | 3 | 2 | 4 | 7 | 3 | 5 | 11 | 13 |
| Frozen | 70 | 60 | 53 | 10 | 6 | 3 | 2 | 4 | 7 | 4 | 23 | 53 | 24 |
| Prob<(in.) 0.1 | 78 | 69 | 60 | 31 | 34 | 31 | 31 | 43 | 46 | 44 | 48 | 66 | 48 |
| 0.2 | 80 | 71 | 64 | 39 | 40 | 37 | 41 | 48 | 54 | 51 | 53 | 69 | 54 |
| 0.3 | 82 | 74 | 66 | 48 | 45 | 42 | 46 | 54 | 59 | 58 | 59 | 72 | 59 |
| 0.4 | 83 | 76 | 68 | 53 | 52 | 45 | 49 | 59 | 63 | 64 | 63 | 74 | 62 |
| 0.5 | 84 | 77 | 70 | 59 | 59 | 51 | 56 | 63 | 67 | 67 | 66 | 76 | 66 |
| 0.6 | 84 | 79 | 74 | 62 | 63 | 56 | 60 | 67 | 71 | 71 | 69 | 78 | 70 |
| 0.7 | 86 | 80 | 77 | 65 | 67 | 60 | 65 | 70 | 74 | 73 | 73 | 81 | 73 |
| 0.8 | 87 | 83 | 80 | 68 | 70 | 65 | 71 | 73 | 77 | 78 | 78 | 82 | 76 |
| 0.9 | 88 | 84 | 81 | 73 | 74 | 68 | 74 | 75 | 79 | 80 | 81 | 84 | 78 |
| 1.0 | 89 | 86 | 83 | 76 | 76 | 71 | 76 | 77 | 81 | 84 | 83 | 85 | 81 |
| 1.1 | 90 | 87 | 85 | 79 | 79 | 75 | 78 | 79 | 83 | 86 | 85 | 86 | 83 |
| 1.2 | 91 | 88 | 86 | 82 | 82 | 77 | 81 | 83 | 85 | 88 | 87 | 87 | 85 |
| 1.3 | 92 | 89 | 87 | 85 | 84 | 80 | 83 | 85 | 85 | 89 | 88 | 88 | 86 |
| 1.4 | 92 | 90 | 89 | 86 | 86 | 81 | 85 | 86 | 89 | 92 | 89 | 89 | 88 |
| 1.5 | 92 | 90 | 90 | 87 | 87 | 82 | 86 | 88 | 90 | 93 | 91 | 90 | 89 |
| 1.6 | 93 | 91 | 91 | 88 | 89 | 83 | 87 | 90 | 92 | 94 | 92 | 93 | 90 |
| 1.7 | 93 | 92 | 92 | 90 | 91 | 86 | 89 | 92 | 93 | 95 | 92 | 94 | 91 |
| 1.8 | 94 | 92 | 92 | 91 | 92 | 88 | 89 | 92 | 94 | 95 | 93 | 94 | 92 |
| 1.9 | 94 | 93 | 93 | 92 | 94 | 89 | 91 | 93 | 95 | 96 | 94 | 94 | 93 |
| 2.0 | 95 | 94 | 94 | 93 | 95 | 89 | 92 | 94 | 95 | 96 | 95 | 95 | 94 |
| 2.1 | 95 | 95 | 95 | 94 | 95 | 91 | 93 | 94 | 96 | 96 | 95 | 96 | 95 |
| 2.2 | 95 | 95 | 95 | 95 | 96 | 91 | 94 | 95 | 96 | 96 | 96 | 96 | 95 |
| 2.3 | 95 | 95 | 96 | 95 | 96 | 92 | 95 | 96 | 96 | 96 | 97 | 96 | 96 |
| 2.4 | 95 | 97 | 97 | 95 | 96 | 92 | 96 | 97 | 97 | 96 | 97 | 96 | 96 |
| 2.5 | 96 | 97 | 97 | 96 | 97 | 93 | 96 | 97 | 97 | 96 | 97 | 96 | 96 |
| 2.6 | 96 | 97 | 97 | 96 | 97 | 94 | 97 | 98 | 98 | 98 | 97 | 97 | 97 |

Table A3.3. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 96 | 98 | 98 | 97 | 98 | 94 | 97 | 98 | 98 | 99 | 97 | 97 | 97 |
| 2.8 | 96 | | 98 | | | 95 | 98 | | | | 97 | 97 | 97 |
| 2.9 | 97 | | 99 | | | 95 | | | | | 97 | 97 | 98 |
| 3.0 | | 99 | | | 99 | 96 | | | | | 98 | 97 | |
| 3.1 | | | | 98 | | 97 | | 99 | 99 | 100 | 98 | 99 | |
| 3.2 | | | | 98 | | 97 | | | | | 99 | | 99 |
| 3.3 | 98 | | | 99 | | 99 | | | | | | | |
| 3.4 | | | | | | | | | | | | | |
| 3.5 | | | | | | | 99 | | | | | | |
| 3.6 | | | | | | | | 100 | | | | | |
| 3.7 | | | | | | | | | 100 | | | | |
| 3.8 | | | | | | | | | | | 100 | | |
| 3.9 | | | | | | | | | | | | | |
| 4.0 | 99 | | | | | | | | | | | 99 | |
| 4.1 | | | | | | | | | | | | | |
| 4.2 | | | | | | | | | | | | | |
| 4.3 | | 100 | | | | | | | | | | | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | | | | 100 | | | | | | | | | 100 |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | | | | 100 | 100 | | | | | | | |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | | |
| 5.1 | | | | | | | | | | | | | |
| 5.2 | | | 100 | | | | | | | | | | |
| 5.3 | 100 | | 100 | | | | 100 | | | | | 100 | |

Table A3.4. Cumulative Distribution Function
Rockville, Indiana (1948-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data | 19 | 18 | 17 | 14 | 11 | 10 | 7 | 7 | 9 | 8 | 6 | 12 | 11 |
| Frozen | 71 | 60 | 36 | 14 | 11 | 10 | 7 | 7 | 9 | 8 | 22 | 59 | 26 |
| Prob<(in.) 0.1 | 79 | 72 | 49 | 39 | 38 | 38 | 38 | 45 | 50 | 51 | 52 | 68 | 52 |
| 0.2 | 81 | 75 | 56 | 45 | 45 | 44 | 43 | 53 | 57 | 57 | 58 | 73 | 57 |
| 0.3 | 82 | 78 | 60 | 51 | 52 | 51 | 48 | 59 | 61 | 63 | 63 | 75 | 62 |
| 0.4 | 83 | 80 | 64 | 55 | 57 | 54 | 52 | 64 | 65 | 68 | 72 | 77 | 66 |
| 0.5 | 84 | 81 | 68 | 61 | 60 | 59 | 58 | 67 | 68 | 73 | 76 | 80 | 70 |
| 0.6 | 85 | 82 | 73 | [illegible] | 66 | 64 | 63 | 72 | 72 | 78 | 78 | 82 | 73 |
| 0.7 | 87 | 84 | 76 | 66 | 71 | 67 | 66 | 74 | 75 | 80 | 81 | 84 | 76 |
| 0.8 | 88 | 86 | 78 | 68 | 73 | 69 | 68 | 77 | 80 | 84 | 83 | 86 | 78 |
| 0.9 | 89 | 87 | 81 | 72 | 76 | 72 | 72 | 80 | 81 | 86 | 85 | 88 | 81 |
| 1.0 | 89 | 89 | 84 | 76 | 79 | 75 | 76 | 82 | 83 | 88 | 87 | 89 | 83 |
| 1.1 | 90 | 90 | 86 | 79 | 80 | 77 | 78 | 84 | 85 | 89 | 89 | 90 | 85 |
| 1.2 | 90 | 91 | 88 | 82 | 83 | 79 | 81 | 86 | 87 | 90 | 90 | 91 | 86 |
| 1.3 | 91 | 92 | [illegible] | 83 | 86 | 80 | 83 | 87 | 89 | 91 | 91 | 92 | 88 |
| 1.4 | 92 | 93 | 92 | 87 | 88 | 83 | 85 | 88 | 90 | 92 | 92 | 93 | 90 |
| 1.5 | 92 | 94 | 92 | 88 | 91 | 85 | 86 | 90 | 91 | 92 | 93 | 93 | 91 |
| 1.6 | 92 | 94 | 93 | 90 | 91 | 87 | 87 | 91 | 92 | 93 | 93 | 94 | 91 |
| 1.7 | 92 | 95 | 93 | 91 | 92 | 88 | 89 | 92 | 93 | 93 | 94 | 94 | 92 |
| 1.8 | 92 | 95 | 94 | 92 | 92 | 90 | 90 | 92 | 95 | 94 | 95 | 95 | 93 |
| 1.9 | 93 | 96 | 95 | 93 | 93 | 91 | 91 | 93 | 95 | 95 | 96 | 95 | 94 |
| 2.0 | 94 | 97 | 95 | 94 | 94 | 92 | 92 | 94 | 96 | 97 | 96 | 96 | 95 |
| 2.1 | 94 | 98 | 95 | 96 | 94 | 93 | 92 | 95 | 96 | 97 | 97 | 96 | 95 |
| 2.2 | 95 | 98 | 96 | 96 | 95 | 93 | 92 | 96 | 96 | 97 | 97 | 96 | 96 |
| 2.3 | 95 | 99 | 96 | 97 | 96 | 94 | 93 | 96 | 97 | 97 | 97 | 96 | 96 |
| 2.4 | 96 | 99 | 97 | 97 | 96 | 95 | 95 | 97 | 97 | 98 | 97 | 97 | 97 |
| 2.5 | 96 | 99 | 97 | 95 | 97 | 95 | 95 | 97 | 97 | 98 | 98 | 97 | 97 |
| 2.6 | 97 | 99 | 98 | 98 | 97 | 96 | 95 | 98 | 98 | 98 | 98 | 97 | 97 |

Table A3.4. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 97 | 100 | 98 | 99 | 98 | 96 | 95 | 98 | 98 | 98 | 98 | 97 | 97 |
| 2.8 | | | | | | | 96 | 99 | | | | | 98 |
| 2.9 | | | | | | | | 99 | | | | | |
| 3.0 | | | | | | | | 100 | | | 99 | | |
| 3.1 | | | | | | | 97 | | | | | | |
| 3.2 | 98 | | 99 | | | | | | 99 | 99 | | 98 | |
| 3.3 | | | | | | | | | | | | | |
| 3.4 | | | | | 99 | 97 | 98 | | | | | | 99 |
| 3.5 | | | | | | | | | | | | | |
| 3.6 | | | | 100 | | | | | 100 | | | | |
| 3.7 | | | | | | | 99 | | | | | | |
| 3.8 | | | | | | 98 | | | | | 100 | | |
| 3.9 | | | | | | | | | | | | 99 | |
| 4.0 | | | | | | | | | | 100 | | | |
| 4.1 | | | | | | | | | | | | | |
| 4.2 | | | | | 100 | | | | | | | | |
| 4.3 | | | | | | | | | | | | | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | | | | | | 99 | | | | | | | |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | | | | | | | | | | | | 100 |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | 100 | | | | | | |
| 5.1 | 99 | | | | | | | | | | | | |
| 5.2 | 100 | | | | | | | | | | | | |
| 5.3 | | | 100 | | | 100 | | | | | | 100 | |

Table A3.5. Cumulative Distribution Function
Rushville, Indiana (1948-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data | 21 | 28 | 18 | 10 | 14 | 9 | 11 | 7 | 10 | 7 | 9 | 14 | 13 |
| Frozen | 75 | 72 | 44 | 13 | 14 | 9 | 11 | 7 | 10 | 8 | 8 | 63 | 29 |
| Prob<(in.) 0.1 | 82 | 79 | 59 | 36 | 37 | 37 | 38 | 43 | 46 | 45 | 52 | 73 | 52 |
| 0.2 | 83 | 80 | 59 | 48 | 44 | 44 | 45 | 50 | 53 | 53 | 57 | 76 | 58 |
| 0.3 | 85 | 82 | 65 | 52 | 50 | 50 | 49 | 55 | 60 | 59 | 63 | 79 | 62 |
| 0.4 | 86 | 84 | 69 | 57 | 55 | 54 | 56 | 63 | 65 | 64 | 69 | 81 | 67 |
| 0.5 | 86 | 86 | 73 | 61 | 59 | 59 | 60 | 67 | 68 | 70 | 75 | 82 | 70 |
| 0.6 | 87 | 88 | 75 | 64 | 64 | 61 | 64 | 71 | 72 | 74 | 78 | 84 | 73 |
| 0.7 | 88 | 89 | 78 | 69 | 69 | 66 | 69 | 74 | 75 | 78 | 81 | 85 | 77 |
| 0.8 | 89 | 90 | 81 | 73 | 73 | 70 | 72 | 78 | 77 | 81 | 83 | 86 | 79 |
| 0.9 | 91 | 91 | 83 | 77 | 76 | 74 | 75 | 80 | 80 | 85 | 85 | 88 | 82 |
| 1.0 | 91 | 92 | 84 | 80 | 80 | 77 | 76 | 82 | 82 | 87 | 87 | 90 | 84 |
| 1.1 | 92 | 93 | 85 | 82 | 82 | 80 | 79 | 84 | 85 | 89 | 88 | 91 | 86 |
| 1.2 | 93 | 94 | 86 | 84 | 84 | 83 | 80 | 86 | 88 | 90 | 89 | 93 | 88 |
| 1.3 | 93 | 94 | 88 | 86 | 85 | 85 | 82 | 88 | 89 | 92 | 91 | 94 | 89 |
| 1.4 | 94 | 95 | 89 | 89 | 87 | 87 | 85 | 89 | 91 | 93 | 92 | 94 | 90 |
| 1.5 | 95 | 95 | 91 | 91 | 89 | 88 | 86 | 90 | 92 | 93 | 93 | 95 | 91 |
| 1.6 | 95 | 95 | 92 | 93 | 90 | 90 | 88 | 92 | 92 | 95 | 94 | 95 | 93 |
| 1.7 | 95 | 96 | 93 | 93 | 92 | 90 | 89 | 93 | 94 | 95 | 95 | 96 | 93 |
| 1.8 | 95 | 96 | 94 | 94 | 92 | 91 | 90 | 94 | 95 | 96 | 96 | 97 | 94 |
| 1.9 | 96 | 96 | 95 | 95 | 93 | 91 | 91 | 95 | 95 | 96 | 96 | 97 | 95 |
| 2.0 | 96 | 96 | 95 | 95 | 94 | 91 | 92 | 96 | 96 | 96 | 97 | 97 | 95 |
| 2.1 | 96 | 96 | 95 | 96 | 94 | 92 | 93 | 97 | 96 | 98 | 97 | 97 | 96 |
| 2.2 | 96 | 97 | 95 | 96 | 95 | 93 | 94 | 98 | 97 | 98 | 97 | 97 | 96 |
| 2.3 | 96 | 97 | 96 | 97 | 95 | 94 | 94 | 98 | 97 | 98 | 97 | 97 | 96 |
| 2.4 | 97 | 97 | 96 | 97 | 96 | 94 | 94 | 98 | 98 | 99 | 98 | 97 | 97 |
| 2.5 | 97 | 97 | 96 | 98 | 96 | 95 | 95 | 98 | 98 | 100 | 98 | 97 | 97 |
| 2.6 | 97 | 98 | 96 | 98 | 97 | 95 | 95 | 99 | 98 | 100 | 98 | 97 | 97 |

Table A3.5. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 97 | 98 | 97 | 98 | 97 | 96 | 96 | 99 | 98 | 100 | 98 | 97 | 98 |
| 2.8 | 97 | 99 | | 98 | | | 96 | 99 | 99 | | 99 | | |
| 2.9 | 98 | | | 99 | | | 96 | 100 | | | | | |
| 3.0 | | | | | | | 97 | | | | | | |
| 3.1 | | | 98 | | 98 | 97 | 97 | | | | | 98 | |
| 3.2 | | | | | | | 98 | | | | | | 99 |
| 3.3 | | 100 | | | | | | | | | | | |
| 3.4 | | | | | | 98 | | | | | | | |
| 3.5 | | | | 100 | | | | | | | | | |
| 3.6 | | | | | | | 99 | | | | | | |
| 3.7 | | | | | 99 | | | | | | | | |
| 3.8 | | | | | | | | | | | | | |
| 3.9 | | | | | | | 100 | | 100 | | 100 | | |
| 4.0 | | | | | | 99 | | | | | | 99 | |
| 4.1 | | | | | | | | | | | | | |
| 4.2 | | | | | | | | | | | | | |
| 4.3 | | | | | | | | | | | | | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | | | | | | | | | | | | | |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | | | | | | | | | | | | |
| 4.8 | 99 | | | | 100 | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | | |
| 5.1 | | | 99 | | | | | | | | | | 100 |
| 5.2 | | | 99 | | | | | | | | | | |
| 5.3 | 100 | | 100 | | | 100 | | | | | | 100 | |

Table A3.6. Cumulative Distribution Function
Spencer, Indiana (1950-1977).
Page 1 of 2.

| | | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data | | 10 | 8 | 9 | 12 | 9 | 7 | 3 | 3 | 2 | 9 | 19 | 11 | 8 |
| Frozen | | 68 | 57 | 30 | 14 | 9 | 7 | 3 | 3 | 2 | 10 | 30 | 61 | 24 |
| Prob<(in.) | 0.1 | 78 | 67 | 44 | 37 | 36 | 32 | 37 | 38 | 42 | 50 | 54 | 70 | 49 |
| | 0.2 | 79 | 71 | 48 | 42 | 43 | 38 | 43 | 47 | 49 | 57 | 57 | 75 | 54 |
| | 0.3 | 81 | 73 | 54 | 47 | 48 | 45 | 47 | 52 | 56 | 63 | 62 | 77 | 59 |
| | 0.4 | 82 | 75 | 59 | 52 | 54 | 49 | 53 | 57 | 63 | 69 | 66 | 79 | 63 |
| | 0.5 | 83 | 76 | 64 | 57 | 60 | 53 | 59 | 62 | 68 | 73 | 71 | 81 | 67 |
| | 0.6 | 84 | 78 | 68 | 63 | 63 | 57 | 65 | 66 | 71 | 78 | 75 | 82 | 71 |
| | 0.7 | 85 | 80 | 71 | 67 | 66 | 60 | 67 | 69 | 75 | 80 | 78 | 84 | 74 |
| | 0.8 | 85 | 82 | 74 | 72 | 70 | 62 | 69 | 73 | 77 | 83 | 81 | 86 | 76 |
| | 0.9 | 86 | 84 | 77 | 77 | 74 | 68 | 72 | 75 | 81 | 85 | 84 | 87 | 79 |
| | 1.0 | 87 | 86 | 79 | 79 | 77 | 73 | 74 | 78 | 82 | 88 | 87 | 89 | 82 |
| | 1.1 | 89 | 87 | 81 | 81 | 80 | 75 | 78 | 80 | 83 | 90 | 88 | 89 | 84 |
| | 1.2 | 89 | 88 | 83 | 84 | 84 | 77 | 79 | 83 | 86 | 91 | 89 | 91 | 85 |
| | 1.3 | 90 | 89 | 85 | 85 | 85 | 80 | 82 | 85 | 86 | 93 | 91 | 92 | 87 |
| | 1.4 | 91 | 90 | 86 | 87 | 87 | 81 | 84 | 87 | 89 | 93 | 92 | 92 | 88 |
| | 1.5 | 91 | 91 | 87 | 90 | 88 | 83 | 86 | 88 | 89 | 93 | 92 | 93 | 89 |
| | 1.6 | 92 | 92 | 89 | 91 | 89 | 85 | 87 | 89 | 90 | 94 | 93 | 93 | 90 |
| | 1.7 | 92 | 93 | 90 | 92 | 91 | 86 | 89 | 90 | 90 | 95 | 93 | 94 | 91 |
| | 1.8 | 92 | 93 | 91 | 93 | 92 | 87 | 90 | 91 | 91 | 96 | 94 | 95 | 92 |
| | 1.9 | 93 | 95 | 92 | 94 | 93 | 88 | 92 | 93 | 92 | 97 | 94 | 95 | 93 |
| | 2.0 | 93 | 96 | 94 | 95 | 94 | 89 | 94 | 93 | 93 | 97 | 95 | 96 | 94 |
| | 2.1 | 94 | 96 | 94 | 96 | 95 | 89 | 95 | 94 | 94 | 97 | 95 | 96 | 95 |
| | 2.2 | 94 | 96 | 95 | 97 | 95 | 90 | 95 | 96 | 95 | 97 | 96 | 97 | 95 |
| | 2.3 | 95 | 97 | 96 | 97 | 95 | 91 | 95 | 96 | 95 | 97 | 97 | 97 | 96 |
| | 2.4 | 95 | 97 | 97 | 98 | 96 | 91 | 96 | 96 | 96 | 98 | 97 | 97 | 96 |
| | 2.5 | 95 | 97 | 97 | 99 | 96 | 92 | 96 | 97 | 96 | 98 | 98 | 97 | 97 |
| | 2.6 | 96 | 97 | 97 | 99 | 97 | 93 | 96 | 97 | 96 | 98 | 98 | 97 | 97 |

Table A3.6. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 96 | 97 | 97 | 99 | 97 | 93 | 96 | 98 | 97 | 98 | 99 | 97 | 97 |
| 2.8 | | 98 | 99 | | | 94 | 97 | | | 99 | | | |
| 2.9 | | 99 | | | | | | | | | | | |
| 3.0 | | | | 100 | 98 | | | 99 | 98 | | | | 98 |
| 3.1 | | | | | | | | | | | 99 | 98 | |
| 3.2 | | | | | | | | | | | | | |
| 3.3 | | | | | | 95 | 98 | | | | | | |
| 3.4 | 97 | | | | | | | | | | | | |
| 3.5 | | | | | | | | | | | | | |
| 3.6 | | 100 | | | | | | | | | | | |
| 3.7 | | | | | 99 | | 99 | | | | | | |
| 3.8 | | | | | | 96 | | 100 | | | | | |
| 3.9 | | | | | | | | | 99 | | | | 99 |
| 4.0 | | | 99 | | | | | | | | | | |
| 4.1 | | | | | | 97 | | | | | | | |
| 4.2 | | | | | | | | | 100 | | | | |
| 4.3 | | | | | | 98 | | | | 100 | | | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | 98 | | | | | | | | | | | | |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | | | | | | | | | | 100 | | |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | | |
| 5.1 | | | | | | | | | | | | | |
| 5.2 | 99 | | | | | | | | | | | | |
| 5.3 | 100 | | 100 | | 100 | 100 | 100 | | | | | 100 | 100 |

Table A3.7. Cumulative Distribution Function
Valparaiso, Indiana (1948-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data Frozen | 9 | 15 | 11 | 6 | 1 | 1 | 0 | 1 | 0 | 4 | 8 | 10 | 5 |
| Prob<(in.) | 83 | 81 | 45 | 9 | 1 | 1 | 0 | 1 | 0 | 4 | 29 | 73 | 27 |
| 0.1 | 85 | 85 | 55 | 28 | 30 | 31 | 30 | 36 | 39 | 42 | 53 | 78 | 49 |
| 0.2 | 86 | 86 | 59 | 38 | 38 | 36 | 38 | 44 | 45 | 49 | 61 | 81 | 55 |
| 0.3 | 88 | 87 | 65 | 44 | 46 | 42 | 43 | 50 | 52 | 55 | 67 | 83 | 60 |
| 0.4 | 88 | 87 | 70 | 50 | 51 | 51 | 48 | 56 | 58 | 60 | 71 | 84 | 64 |
| 0.5 | 89 | 89 | 73 | 55 | 55 | 54 | 55 | 59 | 63 | 67 | 76 | 87 | 68 |
| 0.6 | 89 | 90 | 77 | 61 | 61 | 59 | 62 | 63 | 69 | 72 | 81 | 88 | 73 |
| 0.7 | 90 | 90 | 79 | 65 | 66 | 62 | 67 | 68 | 71 | 75 | 84 | 89 | 76 |
| 0.8 | 91 | 91 | 81 | 68 | 71 | 67 | 72 | 71 | 75 | 79 | 88 | 91 | 79 |
| 0.9 | 92 | 91 | 82 | 71 | 75 | 71 | 76 | 75 | 78 | 81 | 90 | 91 | 81 |
| 1.0 | 92 | 92 | 84 | 74 | 79 | 74 | 79 | 78 | 80 | 83 | 90 | 92 | 83 |
| 1.1 | 92 | 93 | 87 | 77 | 81 | 77 | 82 | 80 | 81 | 85 | 91 | 92 | 85 |
| 1.2 | 93 | 93 | 89 | 80 | 83 | 79 | 83 | 82 | 83 | 86 | 92 | 93 | 86 |
| 1.3 | 93 | 94 | 89 | 83 | 84 | 81 | 86 | 85 | 85 | 87 | 93 | 94 | 88 |
| 1.4 | 93 | 94 | 91 | 84 | 87 | 83 | 88 | 86 | 87 | 89 | 94 | 94 | 89 |
| 1.5 | 94 | 94 | 92 | 86 | 88 | 84 | 89 | 87 | 89 | 90 | 94 | 94 | 90 |
| 1.6 | 94 | 95 | 93 | 88 | 90 | 87 | 91 | 90 | 89 | 91 | 95 | 95 | 91 |
| 1.7 | 94 | 95 | 94 | 90 | 91 | 89 | 91 | 91 | 90 | 92 | 96 | 95 | 92 |
| 1.8 | 95 | 96 | 94 | 92 | 92 | 90 | 92 | 93 | 91 | 94 | 96 | 95 | 93 |
| 1.9 | 95 | 96 | 94 | 92 | 93 | 91 | 93 | 94 | 91 | 95 | 96 | 96 | 94 |
| 2.0 | 95 | 96 | 95 | 93 | 94 | 93 | 94 | 94 | 92 | 95 | 97 | 96 | 94 |
| 2.1 | 96 | 97 | 95 | 94 | 94 | 93 | 95 | 94 | 93 | 95 | 97 | 96 | 95 |
| 2.2 | 96 | 97 | 96 | 95 | 95 | 94 | 95 | 96 | 93 | 96 | 97 | 97 | 96 |
| 2.3 | 96 | 97 | 97 | 96 | 96 | 95 | 96 | 96 | 94 | 96 | 98 | 97 | 96 |
| 2.4 | 96 | 97 | 97 | 96 | 96 | 95 | 96 | 97 | 94 | 97 | 98 | 97 | 96 |
| 2.5 | 97 | 97 | 97 | 97 | 96 | 96 | 96 | 98 | 95 | 97 | 98 | 97 | 97 |
| 2.6 | 97 | 97 | 97 | 97 | 96 | 96 | 96 | 99 | 95 | 97 | 99 | 97 | 97 |

Table A.3.7. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 97 | 98 | 98 | 97 | 97 | 96 | 96 | 99 | 95 | 97 | 99 | 97 | 97 |
| 2.8 | | | | | | 97 | 97 | | 96 | 97 | | | 97 |
| 2.9 | | | | 98 | | | | | 96 | 98 | | | 98 |
| 3.0 | | | | | | | | | 97 | | | | |
| 3.1 | | | | | 98 | 98 | 98 | 100 | | | | 98 | |
| 3.2 | | | | | 98 | | | | | | | | |
| 3.3 | 98 | | | 99 | 99 | | | | | | | | |
| 3.4 | | | | | | 99 | 99 | | | | | | 99 |
| 3.5 | | | | | | | | | | 99 | | | |
| 3.6 | | | | | | | | | 98 | | | | |
| 3.7 | | | | | | | | | | | | | |
| 3.8 | | 99 | | | | | | | | | | 99 | |
| 3.9 | | | | 100 | | | | | | | 100 | | |
| 4.0 | | | | | | | | | | | | | |
| 4.1 | | | | | | 100 | | | 99 | | | | |
| 4.2 | | | | | | | | | | | | | |
| 4.3 | | | | | | | | | | | | | |
| 4.4 | | | 99 | | | | | | 100 | | | | |
| 4.5 | | | | | | | | | | | | | |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | | | | 100 | | | | | | | | |
| 4.8 | | 100 | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | 100 | | | | | | |
| 5.1 | | | | | | | | | | | | | 100 |
| 5.2 | | | | | | | | | | | | | |
| ≥ 5.3 | 100 | | 100 | | | | | | | 100 | | 100 | |

Table A3.8. Cumulative Distribution Function
Vevay, Indiana (1961-1977).
Page 1 of 2.

| | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bad Data Frozen | 8 | 6 | 2 | 6 | 13 | 9 | 1 | 0 | 2 | 1 | 6 | 1 | 5 |
| Prob<(in.) | 60 | 46 | 14 | 6 | 13 | 9 | 1 | 0 | 2 | 1 | 15 | 41 | 17 |
| 0.1 | 73 | 61 | 31 | 27 | 43 | 42 | 28 | 38 | 43 | 43 | 46 | 58 | 44 |
| 0.2 | 75 | 66 | 36 | 34 | 49 | 46 | 35 | 45 | 51 | 52 | 53 | 63 | 50 |
| 0.3 | 78 | 71 | 41 | 40 | 56 | 52 | 44 | 53 | 55 | 62 | 60 | 68 | 57 |
| 0.4 | 80 | 72 | 47 | 45 | 59 | 58 | 52 | 56 | 62 | 68 | 66 | 71 | 61 |
| 0.5 | 81 | 74 | 53 | 51 | 65 | 64 | 56 | 65 | 67 | 74 | 68 | 73 | 66 |
| 0.6 | 83 | 76 | 58 | 55 | 70 | 66 | 60 | 69 | 71 | 77 | 71 | 76 | 69 |
| 0.7 | 85 | 80 | 63 | 61 | 74 | 69 | 65 | 71 | 74 | 79 | 76 | 79 | 73 |
| 0.8 | 87 | 82 | 68 | 65 | 76 | 73 | 71 | 74 | 76 | 80 | 80 | 81 | 76 |
| 0.9 | 89 | 85 | 71 | 70 | 78 | 74 | 76 | 76 | 80 | 83 | 82 | 83 | 79 |
| 1.0 | 90 | 86 | 75 | 74 | 80 | 77 | 79 | 78 | 83 | 83 | 85 | 86 | 81 |
| 1.1 | 91 | 91 | 77 | 76 | 82 | 80 | 82 | 83 | 85 | 86 | 87 | 88 | 84 |
| 1.2 | 93 | 88 | 79 | 79 | 83 | 83 | 84 | 84 | 86 | 87 | 89 | 89 | 85 |
| 1.3 | 93 | 89 | 83 | 81 | 86 | 83 | 87 | 85 | 87 | 87 | 92 | 92 | 87 |
| 1.4 | 94 | 90 | 84 | 82 | 87 | 85 | 87 | 87 | 89 | 89 | 93 | 92 | 88 |
| 1.5 | 94 | 91 | 84 | 85 | 89 | 85 | 88 | 88 | 89 | 91 | 94 | 94 | 89 |
| 1.6 | 94 | 91 | 86 | 86 | 91 | 86 | 89 | 91 | 90 | 94 | 95 | 94 | 91 |
| 1.7 | 94 | 92 | 86 | 89 | 93 | 88 | 91 | 91 | 91 | 96 | 96 | 94 | 92 |
| 1.8 | 95 | 92 | 88 | 91 | 94 | 90 | 92 | 91 | 92 | 97 | 96 | 95 | 93 |
| 1.9 | 95 | 92 | 90 | 92 | 95 | 90 | 92 | 92 | 92 | 98 | 97 | 95 | 93 |
| 2.0 | 95 | 92 | 91 | 94 | 95 | 91 | 92 | 94 | 93 | 98 | 97 | 95 | 94 |
| 2.1 | 96 | 92 | 91 | 95 | 95 | 93 | 92 | 95 | 94 | 98 | 97 | 96 | 95 |
| 2.2 | 96 | 93 | 91 | 96 | 96 | 93 | 93 | 96 | 94 | 99 | 98 | 96 | 95 |
| 2.3 | 97 | 93 | 93 | 96 | 97 | 93 | 94 | 96 | 95 | 99 | 98 | 97 | 96 |
| 2.4 | 97 | 93 | 93 | 97 | 97 | 94 | 95 | 97 | 96 | 99 | 98 | 98 | 96 |
| 2.5 | 97 | 94 | 93 | 98 | 97 | 95 | 95 | 97 | 96 | 99 | 98 | 98 | 96 |
| 2.6 | 97 | 94 | 94 | 98 | 98 | 96 | 95 | 97 | 96 | 100 | 98 | 98 | 97 |

Table A3.8. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 96 | 94 | 95 | 98 | 98 | 96 | 96 | 97 | 96 | 100 | 99 | 99 | 97 |
| 2.8 | 97 | 95 | | | | 97 | 96 | | 96 | | | | 97 |
| 2.9 | | 96 | | | | | 97 | | 97 | | | | 98 |
| 3.0 | | | | | | | 97 | | | | | | |
| 3.1 | | 98 | 96 | 99 | | 98 | 98 | | | | | | |
| 3.2 | | | | | 99 | | | | 98 | | | | |
| 3.3 | | 99 | | | | | | | 99 | | | | |
| 3.4 | 98 | | | | | 99 | 99 | 98 | | | | | 99 |
| 3.5 | | | | | | | | | | | | | |
| 3.6 | | | | | | | | | | | | | |
| 3.7 | | | | | | | | | | | | 100 | |
| 3.8 | | 100 | 97 | | | | | | | | | | |
| 3.9 | | | | | | | | | | | | | |
| 4.0 | | | | | | 100 | | | | | | | |
| 4.1 | | | | | | | | | 100 | | | | |
| 4.2 | | | | | | | | 99 | | | | | |
| 4.3 | | | 98 | | | | 100 | | | | 100 | | |
| 4.4 | | | | | | | | | | | | | 100 |
| 4.5 | | | | 100 | | | | | | | | | |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | 99 | | 99 | | | | | | | | | | |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | 100 | | | | | | | | |
| 5.0 | | | | | | | | | | | | | |
| 5.1 | | | | | | | | | | | | | |
| 5.2 | | | | | | | | | | | | | |
| ≥ 5.3 | 100 | | 100 | | | | | 100 | | | | | |

Table A3.9. Cumulative Distribution Function
Waterloo, Indiana (1948-1977).
Page 1 of 2.

| Bad Data | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frozen | 19 | 14 | 17 | 6 | 5 | 3 | 5 | 4 | 3 | 8 | 10 | 8 | 9 |
| Prob<(in.) | 83 | 77 | 48 | 10 | 5 | 3 | 5 | 4 | 3 | 8 | 32 | 73 | 29 |
| 0.1 | 86 | 80 | 59 | 33 | 35 | 33 | 34 | 43 | 42 | 49 | 55 | 78 | 52 |
| 0.2 | 87 | 82 | 64 | 43 | 44 | 43 | 43 | 52 | 50 | 53 | 62 | 80 | 58 |
| 0.3 | 87 | 83 | 68 | 49 | 50 | 49 | 50 | 57 | 56 | 61 | 68 | 83 | 63 |
| 0.4 | 88 | 84 | 72 | 56 | 57 | 54 | 55 | 62 | 63 | 68 | 74 | 84 | 68 |
| 0.5 | 89 | 85 | 75 | 62 | 62 | 60 | 64 | 66 | 68 | 74 | 77 | 86 | 72 |
| 0.6 | 90 | 86 | 78 | 68 | 67 | 63 | 68 | 71 | 73 | 78 | 82 | 87 | 76 |
| 0.7 | 91 | 87 | 82 | 72 | 72 | 69 | 72 | 74 | 78 | 82 | 85 | 88 | 79 |
| 0.8 | 92 | 88 | 84 | 76 | 74 | 73 | 76 | 79 | 81 | 83 | 87 | 89 | 82 |
| 0.9 | 92 | 90 | 86 | 81 | 79 | 76 | 79 | 81 | 82 | 86 | 89 | 90 | 84 |
| 1.0 | 93 | 91 | 89 | 84 | 82 | 80 | 81 | 84 | 84 | 88 | 90 | 91 | 86 |
| 1.1 | 93 | 92 | 91 | 86 | 85 | 82 | 83 | 85 | 86 | 88 | 91 | 92 | 88 |
| 1.2 | 94 | 93 | 92 | 89 | 88 | 84 | 85 | 87 | 88 | 89 | 92 | 93 | 89 |
| 1.3 | 94 | 93 | 93 | 90 | 89 | 86 | 87 | 89 | 90 | 91 | 93 | 94 | 91 |
| 1.4 | 95 | 94 | 94 | 92 | 91 | 89 | 88 | 90 | 90 | 92 | 94 | 95 | 92 |
| 1.5 | 95 | 94 | 95 | 93 | 92 | 90 | 90 | 91 | 92 | 93 | 94 | 95 | 93 |
| 1.6 | 96 | 95 | 95 | 95 | 93 | 91 | 91 | 92 | 93 | 93 | 96 | 95 | 94 |
| 1.7 | 96 | 95 | 96 | 95 | 94 | 92 | 92 | 93 | 93 | 94 | 96 | 95 | 94 |
| 1.8 | 97 | 96 | 96 | 96 | 96 | 93 | 94 | 93 | 94 | 95 | 97 | 96 | 95 |
| 1.9 | 97 | 97 | 96 | 97 | 96 | 95 | 95 | 94 | 94 | 95 | 97 | 96 | 96 |
| 2.0 | 97 | 97 | 97 | 98 | 97 | 96 | 95 | 95 | 94 | 96 | 97 | 96 | 96 |
| 2.1 | 97 | 98 | 97 | 98 | 98 | 97 | 95 | 96 | 94 | 96 | 97 | 96 | 97 |
| 2.2 | 97 | 98 | 97 | 98 | 98 | 97 | 96 | 97 | 95 | 96 | 98 | 96 | 97 |
| 2.3 | 97 | 98 | 98 | 99 | 98 | 97 | 96 | 97 | 95 | 97 | 98 | 97 | 97 |
| 2.4 | 98 | 98 | 98 | 99 | 98 | 97 | 96 | 97 | 96 | 97 | 98 | 97 | 97 |
| 2.5 | 98 | 98 | 98 | 99 | 98 | 98 | 97 | 98 | 97 | 97 | 98 | 97 | 98 |
| 2.6 | 98 | 98 | 98 | 99 | 98 | 98 | 97 | 98 | 97 | 98 | 98 | 97 | 98 |

Table A3.9. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 98 | 99 | 98 | 99 | 98 | 98 | 97 | 98 | 98 | 98 | 98 | 97 | 98 |
| 2.8 | | | | | 98 | 99 | 97 | 99 | | | | | |
| 2.9 | | | | | 99 | | 98 | | | | | | |
| 3.0 | | | 99 | | | | | | 99 | 99 | | | 99 |
| 3.1 | | | | | | | | 100 | | | | | |
| 3.2 | | | | 100 | | | | | | | 99 | | |
| 3.3 | | | | | | | 99 | | | | | | |
| 3.4 | | | | | 100 | 100 | | | | | | | |
| 3.5 | | 100 | | | | | | | | | | | |
| 3.6 | | | | | | | | | | | | 98 | |
| 3.7 | 99 | | | | | | | | | | | | |
| 3.8 | | | | | | | | | | | | | |
| 3.9 | | | | | | | 100 | | | | | | |
| 4.0 | | | | | | | | | | | | | |
| 4.1 | | | | | | | | | | | | | |
| 4.2 | | | | | | | | | | | | | |
| 4.3 | | | | | | | | | | | | | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | | | | | | | | | | | | | 100 |
| 4.6 | | | | | | | | | | | | | |
| 4.7 | | | | | | | | | | | | 99 | |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | | |
| 5.1 | | | 100 | | | | | | | | | | |
| 5.2 | | | | | | | | | | | | | |
| ≥ 5.3 | 100 | | | | | | | | 100 | 100 | 100 | 100 | |

Table A3.10. Cumulative Distribution Function
West Lafayette, Indiana (1954-1977).
Page 1 of 2.

| Bad Data | JAN | FEB | MARCH | APRIL | MAY | JUN | JULY | AUG | SEPT | OCT | NOV | DEC | YEARLY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frozen | 2 | 4 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 |
| Prob<(in.) | 79 | 69 | 35 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 26 | 66 | 23 |
| 0.1 | 84 | 76 | 50 | 29 | 33 | 31 | 36 | 40 | 41 | 41 | 53 | 76 | 49 |
| 0.2 | 86 | 80 | 55 | 39 | 40 | 35 | 44 | 49 | 50 | 49 | 62 | 80 | 56 |
| 0.3 | 87 | 82 | 62 | 47 | 47 | 40 | 51 | 55 | 54 | 58 | 68 | 83 | 61 |
| 0.4 | 87 | 84 | 68 | 51 | 52 | 47 | 54 | 60 | 60 | 63 | 74 | 84 | 65 |
| 0.5 | 88 | 87 | 71 | 56 | 56 | 51 | 59 | 61 | 66 | 71 | 77 | 87 | 69 |
| 0.6 | 88 | 89 | 76 | 60 | 62 | 56 | 65 | 65 | 70 | 75 | 80 | 87 | 73 |
| 0.7 | 89 | 91 | 80 | 64 | 65 | 58 | 70 | 69 | 73 | 77 | 84 | 89 | 76 |
| 0.8 | 89 | 91 | 82 | 69 | 71 | 62 | 73 | 74 | 76 | 79 | 87 | 89 | 79 |
| 0.9 | 90 | 92 | 85 | 72 | 75 | 67 | 75 | 77 | 78 | 82 | 88 | 91 | 81 |
| 1.0 | 91 | 94 | 87 | 76 | 77 | 71 | 77 | 80 | 80 | 85 | 89 | 92 | 83 |
| 1.1 | 92 | 94 | 89 | 79 | 79 | 75 | 78 | 81 | 81 | 87 | 91 | 93 | 85 |
| 1.2 | 93 | 95 | 89 | 82 | 82 | 80 | 79 | 82 | 83 | 89 | 92 | 93 | 87 |
| 1.3 | 93 | 96 | 91 | 84 | 86 | 81 | 80 | 86 | 87 | 90 | 93 | 94 | 88 |
| 1.4 | 94 | 96 | 93 | 87 | 88 | 84 | 83 | 89 | 87 | 92 | 95 | 94 | 90 |
| 1.5 | 94 | 97 | 94 | 89 | 89 | 86 | 86 | 89 | 89 | 93 | 96 | 95 | 91 |
| 1.6 | 94 | 97 | 94 | 90 | 90 | 87 | 87 | 90 | 90 | 94 | 97 | 95 | 92 |
| 1.7 | 94 | 98 | 95 | 91 | 91 | 89 | 88 | 91 | 92 | 95 | 97 | 96 | 93 |
| 1.8 | 95 | 98 | 96 | 92 | 92 | 89 | 90 | 92 | 93 | 95 | 97 | 96 | 94 |
| 1.9 | 96 | 98 | 97 | 93 | 92 | 91 | 91 | 92 | 93 | 95 | 99 | 96 | 94 |
| 2.0 | 96 | 98 | 97 | 94 | 93 | 92 | 91 | 92 | 93 | 96 | 99 | 97 | 95 |
| 2.1 | 96 | 99 | 98 | 95 | 94 | 92 | 92 | 93 | 94 | 96 | 98 | 97 | 95 |
| 2.2 | 96 | 99 | 98 | 96 | 94 | 94 | 92 | 94 | 94 | 97 | 99 | 97 | 96 |
| 2.3 | 97 | 99 | 98 | 97 | 94 | 94 | 93 | 94 | 95 | 97 | 98 | 97 | 96 |
| 2.4 | 97 | 99 | 98 | 97 | 96 | 95 | 93 | 95 | 95 | 98 | 98 | 97 | 97 |
| 2.5 | 91 | 99 | 98 | 98 | 97 | 95 | 94 | 95 | 95 | 99 | 99 | 97 | 97 |
| 2.6 | 97 | 99 | 99 | 98 | 97 | 96 | 94 | 96 | 96 | 99 | 99 | 97 | 97 |

Table A3.10. Page 2 of 2.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.7 | 98 | 99 | 99 | 98 | 97 | 97 | 94 | 97 | 96 | 99 | 99 | 97 | 97 |
| 2.8 | | | | 98 | 98 | | 95 | 97 | 97 | | | | 98 |
| 2.9 | | | | 99 | | | 96 | 99 | | | | | |
| 3.0 | | | | | | | 96 | | | | | 98 | |
| 3.1 | | | | | 99 | 98 | 97 | | | | | | |
| 3.2 | | | | | | | | | | | | | 99 |
| 3.3 | 99 | | | | | | | | | | | | |
| 3.4 | | | | | | | 98 | | | | | | |
| 3.5 | | | | | | | | | 98 | | | | |
| 3.6 | | 100 | | | | | | | | | | 99 | |
| 3.7 | | | 100 | | | 99 | 99 | | | | | | |
| 3.8 | | | | | | | | | 99 | 100 | | | |
| 3.9 | | | | | | | | | | | | | |
| 4.0 | | | | 100 | | | | 100 | | | | | |
| 4.1 | | | | | | | | | 100 | | | | |
| 4.2 | | | | | | | | | | | | | |
| 4.3 | | | | | | | | | | | | | |
| 4.4 | | | | | | | | | | | | | |
| 4.5 | | | | | | | | | | | | | |
| 4.6 | | | | | | | | | | | | | 100 |
| 4.7 | | | | | | | | | | | | | |
| 4.8 | | | | | | | | | | | | | |
| 4.9 | | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | 100 | | |
| 5.1 | | | | | | | | | | | | | |
| 5.2 | | | | | | | | | | | | | |
| ≥ 5.3 | 100 | | | | 100 | 100 | 100 | | | | | 100 | |

"THE END"